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17. ABSTRACT (MAX. 250 WORDS) A person in our culture who can fully understand a solution to an insight problem when it is explained to him can still fail to think up the solution himself. Research objectives were (a) to develop a battery of insight-problems for use in this and other problem-solving research, (b) to replicate a training experiment in order to determine what a subject might have learned in a specific situation which could influence non-specific situations, and (c) to attempt to teach subjects strategy which will allow them to transfer specific knowledge to non-specific problem-solving situations.

Three experiments were devised: (1) an experimental group of 20 randomly selected college students was given a hint as to how the battery of problems could be solved, while a similar control group was not. The experimental group was more effective. (2) The second experiment concerned originality of response to a battery of problems, and investigated transfer effects from the first experiment. (3) Experiment three investigated whether subjects could be taught to give themselves hints.

The hypothesis emphasized the strategies people employ. It was expected that one could induce non-specific transfer by teaching strategies. It was concluded that one cannot teach strategies without also providing subjects with a new objective which is served by those strategies. The assuming process is basic to ongoing cognitive processes. A theory of knowledge and instruction which takes into account assumptions is necessary for dealing with the nature of knowledge and the processes involved in its acquisition, retention, and utilization.

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COOPERATIVE RESEARCH PROJECT

NUMBER 1810

PHILLIP BLISS DANIELS

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STRATEGIES TO FACILITATE PROBLEM SOLVING

Cooperative Research Project No. 1810

Phillip Bliss Daniels
Brigham Young University
Provo, Utah

1964

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Chapter 1

Theory and the Analysis of the Problem

The research described in this report concerns the general problem of instruction or training. More specifically, it has to do with the production by training and the assessment of nonspecific transfer effects. The primary objectives of the project are (a) to further develop a battery of insight problems for use in this project and in other problem solving research, (b) to replicate an experiment in training in order to ascertain what subjects might have learned from the special training procedure that could mediate the nonspecific transfer effect observed in that experiment, and (c) to attempt to teach subjects a strategy that will mediate nonspecific transfer effects, not only to the kind of criterion task usually employed in research of this kind, but to the battery of insight problems that is developed in this research.

The project has both practical and theoretical implications. On the practical side, the most important implications are for training and education. The educational system is based on the assumption that what people learn in that system will transfer or carry over to the enterprises of everyday life. This assumption is implicit in the idea of preparation. That persons can learn specific skills that will prepare them for specific jobs is no problem, relatively speaking. However, that persons can learn something that will have general utility, that will produce transfer effects to a wide range of activities, is a much more complicated matter. This is where theory gets implicated. Theory deals with the problems of the nature of the knowledge that mediates nonspecific transfer effects and the conditions under which one acquires and then subsequently utilizes such knowledge. It is being assumed, here,that a systematic investigation of the general problem of transfer of training will be most fruitfully dealt with when it is approached with a particular theoretical system in mind. The results of the investigation tend to feed back upon the theoretical system in ways that lead to its refinement and subsequently, to its greater usefulness.

Implicit in the idea of training is the assumption that the student is changed--learns something--by the training experiences in ways that will affect his performance on subsequent tasks. In other words, what the student learns in one situation carries over and produces a "transfer effect" in another situation. The important questions a theory of instruction must answer have to do with (a) the nature of the mediating knowledge--the nature of the changes made in the subject by the training experience, and (b) the nature of the experiences that lead to the acquisition and utilization of knowledge that will mediate nonspecific transfer effects. The theory of knowledge and instruction employed to think about the problems in this project provide answers to these questions.

The theory is a cognitive theory. Because it is not known by others in its present form, an attempt will be made here to present it but without the elaboration and illustration that would be included in a thorough account of the theory. This account is probably adequate for one who is already familiar with the structural features of man's knowledge and knowledge processes. It may be too sketchy to be meaningful to one who does not have such background. After a presentation of the theory, this chapter will end with a statement of the major hypotheses that are tested by the research.

In this theory, knowledge is regarded as a physical system within the person which represents, stands for, or models reality. There are two main kinds of reality: things and the behavior of things. The first kind of reality consists of objects, or things, that are substances. A number of different terms are employed where reference is made to substantive things. The term "element" is used to refer to any particular thing or object. The terms "situation" and "state" are used interchangeably to mean a set of elements in which the elements that constitute the set are related to each other in some way.

Likewise, a number of different terms are used when reference is made to the behavior of things or situations. Some of these are behavior, action, transformation, event, flux, process, change, and movement.

Since knowledge is a physical mechanism within the person that represents these elements and their behaviors, the theory must deal quite in detail with the nature of a knowledge system. Of course, there are two major classes of knowledge that represent the two major kinds of reality: substantive knowledge and behavioral knowledge. The former consists of knowledge systems that represent elements and situations while the latter consists of knowledge systems that represents the behaviors of elements and systems of elements.

Major Features of a Cognitive Structure

While these two kinds of knowledge may appear to be quite different, the characterization that is about to be made of a particular knowledge system is applicable to both. The following discussion is a brief presentation of the major features of knowledge systems.

The first important feature of knowledge is that it is a structure. This derives from the following fact: The world is experienced in a vast series of encounters with elements and behaviors that recur with considerable regularity. If there were no recurrent regularity or repeating patterns of stimulation, the accumulation of knowledge or development of a knowledge system would probably be impossible. All knowledge about the world grows out of the repetition of patterns of stimulation, some of which are seen by the perceiver as varyingly similar and some of which are seen as varyingly different. It is assumed in this theory that the concept attainment paradigm is the basic process by which either behavioral or substantive knowledge systems develop. It results in the development of a knowledge system that represents the essence, so to speak, of all the previously experienced patterns of stimulation the person has seen as similar in ways that make them different from other patterns they have experienced. Since the knowledge mechanism evolves in this manner, it is of necessity generic. The term "structure" as applied to knowledge mechanisms implies this generic quality.

A second related feature of a knowledge system is that it is highly fractional. This, of course, is implied in the above discussion. It represents only a fractional part of any particular element or behavior it stands for. Furthermore, knowledge systems differ in this respect. One knowledge system may be much more fractional than another. For example, what a child knows about the human body is much more fractional than what a physician knows about it. This is another way of talking about the complexity of cognitive structures or knowledge systems.

A third feature that is also related to the structural quality of a knowledge system is its congruence, fit, or correspondence with the reality it stands for. Knowledge systems differ in how congruent or veridical they are with respect to their referents in reality.

A fourth feature of a knowledge system is its transferability. This means it is applicable to a certain range of elements or events, the range being defined in terms of certain limits on various dimensions and/or the appropriateness or inappropriateness of certain property modifiers to those elements or events. Of course, the fact that knowledge systems are structures, that they are generic, implies a certain amount of transferability. Since knowledge systems differ with respect to how transferable they are, this property of such systems assumes considerable importance in any discussion of education or transfer of training.

The Anatomy of a Cognitive Structure

Consider now, the anatomy of a particular knowledge system. It consists of two basic kinds of knowledge which are sub-systems of the particular knowledge system in question. These are "parts" and "properties." Psychologically, a part is just another element. For example, a knowledge system that stands for a door, while it is part of a knowledge system that stands for a house, is just as much an element as is the house. Psychologically, a house is an integrated system of other knowledge systems that represent the various parts of the house.

The second basic kind of knowledge which often functions as a subsystem of a particular knowledge system is a property. A property is basically adjectival in nature. This means that it is a highly transferable unit of knowledge that can be employed to think about a wide variety of elements or behaviors when the property has not actually been involved with or associated with those elements in the past. When applied to a particular element, a property assumes a fairly specific value and under certain conditions of learning may be intimately associated with the rest of the structure. For example, the idea of one pound--a specific value on the weight dimension--is basically integrated into the knowledge system that stands for butter as we think of buying it in the store.

The fact that a property is the kind of knowledge mechanism that is adjectival in nature means that it differs in some way from the kind of knowledge mechanism that represent parts of things or behaviors. The most important way that it differs from a knowledge system that represents a part is in that it is inherently relational. It plays the central role in the thought processes involved in "seeing" relationships between elements. One may see relationships of similarity, difference, or of varying degrees between these extremes on a dimension. As a matter of fact, all properties are dimensions and they imply either a continuous or a discrete base for comparing or contrasting things and behaviors. If a property cannot be applied to some element, then that element cannot be compared with another element on the dimension that property implies. For example, if one cannot regard a stone as having virtue, then one cannot see the similarity or difference between a stone and a person with regard to virtue. A "relationship" is basically a connection in the person between two knowledge systems that is made possible by the presence of adjectival mechanisms that are applicable to each.

It should be noted that the basic concept attainment paradigm alluded to earlier which provides the basis for the development of knowledge systems in people, involves a continuous relating process in which various elements or behaviors are seen as being similar to and yet different from other elements or behaviors. The basis for these similarity and difference relationships are the properties which are applicable to the various elements or behaviors involved. This similarity-contrast relating process then, depends on the presence of property knowledge systems.

The Cognitive Processes

It is assumed that the cognitive or knowledge processes--perception, recognition, remembering, thinking, and the like--involve the activation of knowledge systems within the person. One of the most striking aspects of the activation of knowledge systems or cognitive structures has to do with the fact that a particular knowledge system can be activated in one of two ways: either as a whole or as a series of parts. Consider, for example the knowledge system that represents a particular house. One can think about a house as a single unit, as a whole, or one can think about the house as a system of interrelated parts. The first kind of thinking involves what is called the "synoptic use of the knowledge mechanism" while the second involves the "analytic use of the knowledge mechanism."

The occasion for synoptic utilization of knowledge is thinking that involves considering some larger situation of which the particular knowledge system in question is a part. For example, if one is thinking about going into a house to secure some object, the house is only a part of this total situation and the time devoted to thinking about the house is relatively short. In this process, the knowledge mechanism that stands for house is activated synoptically, as a whole, or a single unit. Each of the elements in the situation is activated synoptically as it is related to the other elements in the situation.

The occasion for analytic utilization of knowledge is thinking that involves considering the element itself without relating it to other elements. In the house example, one might think about a house. In this case, he considers its parts and/or its properties. The entire time spent in thought is devoted to the house though the time spent on each part may be very short. The house would be thought about analytically in this case, while the respective parts would be thought about synoptically.

In addition to the distinction between synoptic and analytic utilization of knowledge, it is necessary to distinguish between two kinds of analysis. One kind is "element analysis." This involves thinking about the element in terms of its parts, the situation in terms of the elements that constitute it or the behavior in terms of its parts. The second kind of analysis is "property analysis." This involves thinking about the referent in reality in terms of properties that may modify the referent in question. Of course, most analytic thinking is some combination of these two forms of analysis.

The two major ways of utilizing knowledge are applicable to perception as well as to thought. A person who is perceiving the environment may perceive the elements synoptically--as wholes--but perceive the situation of which the elements are parts analytically. Alternatively, he may perceive situations synoptically or elements analytically, depending on factors to be considered below. Analytic perception may be basically an inventorying kind of analysis--element analysis--or it may consist of a property analysis which most often gives rise to a "seeing of relationships" between elements.

Implicit in this discussion of analysis is the assumption that under certain conditions of activation one knowledge system that is already activated will "recruit" or in turn activate another knowledge system. Such recruitment of one cognitive structure by another helps to account for the organization of thought and behavior. The organization of thought is actually based on two major factors. One that will be discussed in some detail later is the major organizing variable in thought. The second has to do with the degree of functional intimacy, integration or involvement of one knowledge system with another. Consider the whole-part problem--the relationship between, for example, the arm and the total body of which the arm is a part. With the synoptic use of knowledge, some fractional portion of the part is activated simultaneously with the other parts that constitute the whole. With the analytic use of knowledge, the various parts are activated sequentially. This calls for an assumption of an extremely intimate organization and integration of knowledge systems. The term "coherence" is employed in this framework to refer to the degree of such involvement of one knowledge system with another. Under some conditions, the recruitment of one cognitive system by another is determined by the degree of coherence that exists between these structures. Of course, high coherence leads to recruitment.

"Imagining" involves the construction of new systems of knowledge out of existing ones. It is achieved throughout a process of relating knowledge systems that are sufficiently integrated to be thought about synoptically into new arrangements and combinations. People construct new knowledge systems by thus re-arranging the existing cognitive structures. The resulting system may become integrated and the person may eventually be able to think of it synoptically.

One of the important assumptions in this theory is that every mature, normal, awake human being is constantly constructing a representation within himself of the world as it exists at the present moment. Of course, he can also remember the representations that have lead up to the existing one. This assumption is the assumption of a "constant reality orientation." It is not assumed that this representation is entirely conscious. What is being assumed is that if one asks a normal person to close his eyes or otherwise restricts his sensory input, and then asks him to report where he is in relation to other parts of the world, he will be able to give a reasonably veridical account.

Of course, in the process of making a construction of the state the world is in at some point in time, the person is always concluding something about the world that may or may not be justified. These conclusions are very often unwitting. That is, the subject is often not aware that he has made such a conclusion and he may proceed as if his construction that is based on that conclusion is justified. Such conclusions about the state of the world are called assumptions. Assumptions are varyingly primitive. That is to say, some assumptions are more unwitting and difficult to recognize than others. The assumption people make when they speak to another person is really quite primitive. For example, they tacitly and unwittingly assume that the other person will understand them. Much of the problem of ineffective thinking stems from unwarranted assumptions and the inability of people to overcome them because they are unwittingly arrived at.

A second assumption in the theory having to do with the constructions people make of the world may be described as the assumption of an "anticipatory orientation." The normal, awake adult always has some system of anticipatory states or situations that he has constructed and that might conceiveably exist in the future. Persons can construct a huge variety of such situation. However, only those that the person desires and undertakes to bring about are included in the class of anticipatory states that involve the anticipatory orientation.

Since the anticipatory state is always a construction of what might eventuate, it is always different from the representation the person has developed of the world as it exists now. This discrepancy between the existing and the anticipated states defines what is referred to in this theory as the person's objective. An "objective" is an anticipatory state the person desires to bring about as it relates to the particular existing reality orientation. In other words, an objective is the desire one has to reduce the discrepancy between the present and the anticipated states. The reason for not identifying the term "objective" solely with the anticipated state is that the latter is always of the future and implies a state that exists in the present but that is generally less desired than the anticipated one. An objective, then, is a purpose. It has to do with the desire for a transformation in the present situation that will culminate in the anticipated one.

There are two major classes of objectives: those that have considerable recurrent regularity in the life of the person and those that are relatively new and recently constructed. The former involve well integrated anticipatory states as these relate to existing ones. Both states, the discrepancy that gives rise to the objective, and the envisioned situational transformation that reduces the discrepancy tend to be activated synoptically. They require little analytic consideration. Because of the intimate involvement of these systems with each other, the strategy, which is a basic part of the envisioned situational transformation, is recruited immediately upon the occurrence of the objective. That is, when the objective occurs, under certain conditions the strategy is immediately recruited and eventuates in the attainment of that objective. The strategy is well practiced and as a result, well integrated so that the person both thinks of it synoptically and executes it synoptically.

The second kind of objective is one that has no recurrent regularity as an overall objective. It is constructed of cognitive systems that may have had considerable recurrent regularity as separate systems, but that have no recurrent regularity in this new combination. Such objectives will not immediately recruit a well practiced and well integrated strategy. The constructed representation that the person develops of the changes that must be made in the arrangement of elements in the existing situation to produce the anticipated one, can be thought about only analytically. It tends not to be thought about synoptically but rather as a sequence of intermediate states. Each of the intermediate states is a change away from the existing one in the direction of the anticipated one. It is also useful to regard these intermediate states as discrepancies from the existing one, and therefore, as an intermediate objective that is organized by the primary one. Each of these objectives may be thought about synoptically and they may recruit some well practiced strategy that may be executed synoptically. But the overall strategy must be executed analytically with careful attention being paid to the various parts of the behavioral sequence.

The Instrument of Purpose

A mature adult person has developed a tremendous number of knowledge systems that he employs to think about the behavior of elements. There are two major classes of behavioral knowledge mechanisms or structures. There are those cognitive structures that the person employs to think about the behavior of things in the world apart from the person himself. On the other hand, there are those cognitive structures that the person employs to think about the behaviors the person himself may engage in. These latter knowledge systems are called "strategies."

Both classes of behavioral knowledge are employed by the person when he undertakes to imagine how the existing situation might be transformed into the anticipated one. In other words, the person uses both kinds of knowledge systems to think about these changes in the arrangements of the relevant elements.

It is necessary to keep this distinction between strategies and other behavioral knowledge systems in mind as we consider how a person goes about introducing changes in the world in order to help bring about an envisioned situational transformation. In other words, the distinction is relevant to the problem of relating the knowledge systems of which the objective is a function to the motor systems--the behaving apparatus--of which the changes in the world are a function. Of course, man is a dynamic living system in possession of both sources of energy and motor systems that operate to produce movement in various parts and organs of his body. He can make movements with his body that will in turn initiate changes in the arrangement of some of the elements in the world outside himself. The reason for distinguishing between strategies and other behavioral knowledge mechanisms is that the former have an intimate involvement with the energy and motor systems of the body. The involvement is such that under certain conditions of activation, they regulate and control the discharge of energy into coordinated physical action. Since the strategy is the instrument of purpose--since it is related to the envisioned situational transformation and the objective associated with it--it provides the link between knowledge and behavior.

Of course, if an objective is newly constructed, the particular envisioned situational transformation involved consists of a series of intermediate objectives, all organized by and in a way that will culminate in the primary objective. This means that the various intermediate objectives will recruit strategies that are appropriate to them.

In sum then, man has a reality orientation which is a conception of the state of the world at the present moment. He also envisions a state of the world which he anticipates actualizing. Out of the disparity between these two, comes a construction of the movements or the changes that must transpire in the existing situation in order for the objective to be attained. This envisioned transformation assumes the form of a series of intermediate states and objectives that ultimately eventuate in the primary objective. He has knowledge mechanisms--strategies--which he employs to think about the part his own behavior will play in this transformation as well as for the effects these behaviors will have on the world outside. Since man has both energy and a motor system that makes possible the discharge, control, and regulation of energy into coordinated physical action, man is able to act in ways that will help him bring about his objectives. Each intermediate objective recruits the strategy that leads to transformations that gradually eventuate in the primary objective. In this way, the gap between his knowledge and his behavior is bridged.

Two Kinds of Strategies

It is necessary at this point to distinguish between two kinds of strategies. The criterion for the distinction is based on the nature of the objective the strategy is designed to attain. One kind of strategy is designed to reduce discrepancies in the state of the world outside the person that is appropriate to a particular situational transformation the person has envisioned. This is called the "problem-specific strategy" since it is concerned with attaining a specific objective in the world. A second kind of strategy is more general and is called a "heuristic." A heuristic is a strategy that is designed to produce a change in the person himself. The change may be learning something new, it may be discovering something about the world, it may be ascertaining an adequate conception of an existing situation, it may be the invention of a new idea for solving a problem. Since this kind of strategy is a fairly general one, it has more general utility than a problem-specific one. Very frequently, though not always, a heuristic is a representation of behaviors a person can engage in with his brain. It is a thinking strategy whose purpose or objective is the invention of a transformation in some particular situation.

While all strategies have some transferability, heuristics tend to have much wider application than problem specific strategies. Accordingly, heuristics are knowledge systems that may mediate general transfer effects and they are, therefore, major mechanisms to be developed if one is to improve the problem solving ability of another person. More will be said in this regard later on.

Conditions for Learning New and/or Utilizing Known Strategies

What conditions must be met before a strategy that is already learned will be utilized, and what conditions must be met before a new strategy will be learned or developed? These two questions are closely related and will be considered in the same discussion.

A strategy has a certain degree of efficacy. In this framework, efficacy is a form of knowledge. It is an adjectival mechanism that tends to be involved with and may help to characterize a particular strategy just as weight or cost might characterize some element. As a property of a strategy, efficacy operates in ways that reflect the degree of confidence a person has in the power of a strategy to actualize or bring about the objective it is designed to produce. A particular strategy does not always have the same degree of efficacy. Since efficacy is a property, inherent in its development is the similarity contrast process. The efficacy of a particular strategy assumes a particular value for a particular objective and only when more than one objective is compared and contrasted on that dimension. That is, a strategy may have high efficacy only if other strategies are similar and/or different on this dimension.

Most of the objectives a person adopts from day to day have great recurrent regularity. Furthermore, the person tends to employ the very same strategy again and again in order to attain these objectives. They may be repeated as long as the strategies retain their efficacy. When the objective recurs, it immediately recruits the strategy that has had the greatest efficacy in the past. In other words, the specific degree of efficacy that is associated with a strategy for a particular objective has been established through the similarity-contrast process as applied to prior utilizations of the strategy for attaining that particular objective.

Occasionally, however, a person will adopt an objective for which the strategy that is immediately recruited on the basis of efficacy derived from past successes, proves inefficacious. It fails to yield the objective it was recruited to attain. When this happens, the person experiences what is referred to in this framework as a "temporary stalemate." Only when a person is thus thwarted in attaining his objective can it be said that he has a problem. A problem situation is one in which a person has an objective but no reasily available strategy for attaining it.

When the person experiences a temporary stalemate, he may not necessarily abandon the original anticipatory state, but he is very likely to adopt a different objective that immediately recruits the most efficacious strategy available for that objective. This different objective may be only slightly different, and at the same level of specificity, or it may be more general which would be the case if the objective has to do with creating changes in the person himself. That is, if the strategy recruited by the objective is a heuristic, then the objective would be of a somewhat different order from some alternative problem specific strategy.

Of course, a new problem specific strategy that is developed by means of a heuristic will consist of a new arrangement of intermediate objectives, each of which may recruit strategies by virtue of demonstrated efficacy. Since the person is able to envision the sequence, he is able to anticipate its efficacy. Should he construct alternative strategies without demonstrated efficacy, he may evaluate each for its anticipated efficacy and then the objective will recruit the one having the greatest apparent efficacy.

In sum then, objectives that recur with some regularity tend to recruit immediately strategies that have demonstrated efficacy in the past. Objectives that have not recurred or for which the solver has no efficacious strategies, result in a temporary stalemate. As a result of the stalemate on this objective, a second objective is adopted. This may also be problem specific and the strategy recruited by this objective may also fail. When the stalemate is relatively severe, the subject may adopt the objective of inventing a new idea for solving the problem. This objective immediately recruits the heuristic. The anticipated efficacy of any problem specific strategies that are constructed as a result of this change in approach to the problem will be evaluated and should it appear to be sufficiently efficacious, the strategy will be recruited by the original objective.

It would appear from this analysis that the conditions that must be met in order for a person to learn a new strategy is (a) that the available problem specific strategies must lead to a stalemate and (b) the heuristic that the subject employs must prove useful in generating specific strategies in order for the efficacy of that heuristic to be great enough to lead to its recruitment in subsequent stalemate situations. Of course, since efficacy of a heuristic develops through a similarity-contrast process, a considerable number of successes must be experienced to contrast with the failures to make possible the involvement of the knowledge mechanism for this property with the objective involved.

The Problem Solving Process

Now, using the language developed in this chapter to talk about the problems of the nature, the acquisition and the utilization of knowledge, consider a specific problem from the battery of insight problems used in this research. The problem is Maier's (1933) classic two-string problem. While it is described in Chapter II and the problem as it was presented to the subjects is contained in Appendix A, a brief description of the problem is necessary at this point. The subject is introduced into a room. Two strings hang from the ceiling of the room far enough apart that holding one, the subject cannot reach the other. A pair of scissors is on the floor near the strings. The subject is instructed that he is to tie the two strings together using only the materials in the room, and he is to accomplish this in some specified amount of time.

The subject begins by looking the situation over. He does this either by perceptual sampling or perceptual monitoring or both. Of course, this is a form of element analysis and probably property analysis as well. He ascertains what elements are in the situation. Presumably, the sensory input initiated by the various elements in the situation activates the knowledge mechanisms within the person that represent those elements. We know that he develops this reality orientation because by having him close his eyes, and then asking him to give an account of the situation, he practically always describes the situation roughly as it has been described above.

Either subsequently, or while he is conducting the analysis, the subject begins to relate the various elements to each other by considering them with respect to each other. We have seen how the theory requires that he have available adjectival knowledge mechanisms or properties before he can see relationships between elements. The properties of the various elements in the situation provide the basis for the relationships between and among the elements. For example, the subject is bound to note the spacial relationship between the two strings as these relate to the length of his own arms, etc. Basically, though he may not be consciously doing so, the subject conducts at least a cursory property analysis of the elements in the situation. Primarily because properties are inherently relational, once these adjectival mechanisms are activated, they provide the basis for comparing various elements to each other. Size properties give rise in the person to size relationships, shape properties to shape relationships, and the like.

By a complex process involving both element and property analyses, the subject develops a conception of the state the world is in at that moment. The strategies he employs to do this are recruited by and are at the service of objectives which tend to operate nearly continually within him. This might be sort of the "let me find out what is going on here," or the "let me find out what I have to work with" objective. These strategies of property and element analysis are designed to produce changes within the person in the form of a revised and realistic conception of the world. Hence, these strategies qualify as heuristics in that they are employed to induce changes in the subject himself and they need not be specific to a particular subject matter.

It should be mentioned that very often subjects will conduct an incomplete element analysis and over-look some element in the situation that must be considered if the objective is to be attained. Also subjects may fail to conduct an adequate property analysis and hence not see some relationship that would suggest a change in relationships that in turn would lead to the appropriate situational transformation. One may terminate the application of these strategies on the assumption that they have served their purpose. This would be an unwitting conclusion that in these cases would not be warranted.

The experimenter provides the subject with the future state of the world and the subjects, all without exception in this project, appear to adopt that objective and immediately set about attaining it. The words employed by the experimenter tend to activate the knowledge mechanisms the subject uses to envision the situation he is to attain. In this case, it is the strings tied together. Having adopted the objective as his own, the subject now undertakes to envision the nature of the situational transformation that will result in the attainment of the objective. He must construct a representation within himself of how the elements in the existing situation may be rearranged to produce the anticipated one. Of course, part of this representation involves his own role in the transformation--his problem-specific strategy or the behaviors he must engage in to alter the world in ways that will suit his purpose. It is apparent to him that the normal course of events will not eventuate in the desired state.

His conception of the situational transformation is derived in large part from the relationships between the existing and the anticipated states. It is the objective which organizes his thought and behavior. For example, he knows how the strings relate to each other at the present moment. They are a certain distance apart and are hanging parallel to each other. He also knows how they would relate to each other in the envisioned state--they would be tied together at one end. From this discrepancy, the subject is led to see that a change must be made in certain spacial relationships that obtain between the lower ends of each string if the objective is to be attained.

Of course, the objective of securing two things and tying them to each other has recurred many times in the life of the individual. Likewise, the strategy that is recruited by that objective has considerable demonstrated efficacy from past successes. Accordingly, given the presence of the objective in the knowledge systems of the person, the strategy with demonstrated efficacy is recruited almost as a whole. The subject experiences a highly fractional representation of the strategy. The strategy, if broken down by the subject might consist of the following parts: he would envision himself walking to one string, grasping it with one hand, walking toward the other string, reaching for it, grasping it, and then tying the two strings together. The knowledge mechanisms employed to envision these intermediate states and their attainment have been employed hundreds of times in the subject's past. As a matter of fact, every time the subject ties his shoes, the basic situational transformation is achieved. It has come to involve pretty much the synoptic use of knowledge in which the subject considers the transformation as a whole without special attention to any of the parts--intermediate states.

When the subject first learned to tie his shoes, he may have envisioned various intermediate states and labored with the attainment of each which finally culminated in the primary objective. At this stage, the use of knowledge was highly analytic in that each part had to be considered in sequence.

Of course, this strategy for the problem fails to yield the anticipated objective since the subject miscalculated the spacial or length relationships between the strings, his arms, body, etc. That is, he unwittingly concluded or assumed that his arms and the first string when drawn toward the second would reach. The information that the discrepancy still exists between the existing and anticipated states is communicated to the subject's knowledge systems via his sensory system and reveals that his conception was not an adequate representation of the existing situation. This coupled with the fact that his own body now bears different relationships to the elements in the situation, leads to a slightly different but more veridical conception of the existing state of the world. This new state, when compared to the envisioned one reveals a slightly different disparity and results in a different objective. That is to say, now the subject sees that his hand does not quite reach the second string. The relationships that are relevant to this disparity have to do with length and distance. Of course, these are the relationships that appear to require changing in order for the objective to be attained. Given the new disparity and a temporary stalemate, the new objective may then recruit a strategy that has occurred frequently in the past and that has, therefore, acquired some efficacy for the person for reducing this kind of objective. The strategy recruited by the objective calls for the subject to change the seen relationships by securing an extension for his arm--get some element that has length and certain size properties that will enable him to hold it in his hand. This very fractional representation of what might be done provides the basis for the construction of various intermediate objectives concerned with locating the extension, securing it, reaching, attaching the string, pulling, and the like. The subject thus envisions the various stages or states that might culminate in the primary objective. Each of the intermediate objectives associated with the respective discrepancies recruits the strategies that have the greatest efficacy, and the resulting coordinated action on the part of the person leads him to locate and employ the scissors to try to reach the second string.

This strategy also fails for this problem since the scissors are not long enough to reach the string even when the subject stretches as far as he can reach. The subject has erroneously assumed something about the distance and the scissors. This results in another temporary stalemate, and a minor revision in the subject's conception of the existing situation. The existing situation now involves the scissors more centrally since they are in the subject's hand and his knowledge mechanism for thinking about the scissors is activated and related to the other elements in the situation in various ways. The new disparity creates an objective which may recruit additional strategies which may also fail. Most of the stalemates that result from these failures tend to be relatively temporary. Eventually, however, some subjects confronted with this problem who finally experience a relatively enduring stalemate, adopt as their intermediate objective, the specific intent to develop a new way to attain the primary objective. This new objective may recruit a heuristic, a fairly general thinking strategy that is designed to help the subject think up or invent a new problem specific solution. Assume for purposes of illustration that the heuristic that is recruited is the method of property analysis. As was indicated earlier, subjects often conduct fairly cursory property analysis on the assumption that it is adequate. The enduring stalemate leads to a re-application of this heuristic.

The subject might more or less sit back and take stock, so to speak, of the elements he already knows are in the situation. Suppose he conducts a property analysis of the strings. While he is contemplating the strings in terms of its properties, it occurs to him that it is very light. The property of the weight of the strings, when activated, tends to recruit the knowledge mechanism for one of the frequently recurring regularities in the environment that involves weight--a swing or a pendulum. It does this because the coherence between the property weight and the larger knowledge system having to do with pendulums is very high due to the intimate involvement of that property with the relationships on which the principle of the pendulum is based. In other words, the idea of a pendulum involves an augmenting weight on a longer arm as well as an oscillating changing of position and consequently of changing spacial relationships. Since the required situational transformation calls for a change in spacial relationships, the subject immediately applies the generic idea of a pendulum to the specific problem confronting him. It becomes the basis for an overall problem-specific strategy with its intermediate objectives of securing some weighted object to tie to the string to augment its weight, drawing the weight up to one side, releasing it, reaching the other string, catching the pendulum on one of its oscillations, and then tying the strings together to achieve the anticipated state and the objective.

What instruction has this analysis for those interested in improving the solving effectiveness of people? This question is answered by a consideration of why normal adult persons in our culture might fail to solve such a problem. It is interesting that practically all such persons readily understand the solution when they are told of it. They can all execute the strategy for solving the problem if given the opportunity. Once they know the solution, they are even amazed that they could not solve the problem. It appears to be so simple. This suggests that they have all the knowledge mechanisms that are necessary for solving the problems. This would appear to include the following: knowledge for thinking about elements in the world such as scissors and string;

knowledge for thinking about situations such as the one subjects are confronted with at the beginning of the problem; knowledge for thinking about situations that do not exist yet such as having two strings that hang from the ceiling tied together; knowledge for thinking about the properties of elements such as flexibility and weight of string or weight of a pair of scissors; knowledge for thinking about the relationships between elements such as distance and relative weight and relative size; knowledge for thinking about the movements one can make with his body such as grasping, reaching, walking; knowledge for thinking about behaviors of elements in the world such as the swinging of pendulums; knowledge for thinking about the effects of one's own movements on the elements in the world such as initiating the swing of a pendulum.

Apparently, the presence of these complex knowledge systems within the person is not sufficient to insure that he will solve the problem. What is missing? The answer appears to involve what the person does when he encounters a temporary stalemate. When the problem-specific strategies that are recruited by the objective all fail to produce the anticipated state, what recourse does the person have? According to the analysis made earlier, those who go on from the temporary stalemate to solve the problem do so by utilizing thinking strategies or heuristics that are designed to help the person capitalize on his own nature to recruit and organize existing knowledge systems into new combinations.

If this is the case, then it is logical that one might improve the effectiveness of another person's problem solving if he could teach that person a heuristic that will help him capitalize on his own nature to achieve his objectives. Since heuristics tend to be fairly general rather than problem specific, they are potential mediators of nonspecific transfer effects.

The major aim of this research is to provide subjects with special experiences that are designed to teach them the heuristic described earlier as the method of property analysis. It is assumed that the special training procedures that will provide these experiences will teach subjects this strategy in a way that will lead to its utilization on the criterion tasks. It is also assumed that the application of this strategy will lead the subject to discover the solution relevant properties of the various elements in the problem situations and that these properties will in turn provide the basis for solution-relevant relationships between those elements. It is also assumed that these relationships have high coherence with the principles or the behavioral knowledge mechanisms that provide the generic solution, and that by virtue of this coherence, they will recruit those principles which lead to the development of a specific solution and the appropriate problem-specific strategy for attaining the primary objective.

Of course, these assumptions represent a series of hypotheses. Since the line of reasoning is quite lengthy, an attempt will be made to test it at two major points. The first experiment in this project involves providing experimental subjects with solution-relevant properties in the form of "hints" and predicting that they will solve more of the problems than control subjects. If they do, then it will appear that those properties do indeed give rise to the solution-relevant relationships and the solution principles. The strategy of property analysis would then appear to be a potential heuristic. If they do not, then it will appear that the analysis is inadequate and the method of property analysis is not a heuristic in the sense that it would help the person capitalize on his available knowledge in new ways to solve the problem, or the assumption that the training procedure will provide the necessary experiences for subjects to learn and/or realize the heuristic is unwarranted.

Should the method of property analysis turn out to be a heuristic, then the next question involves the problem of teaching persons to apply it, to give themselves hints, so to speak. This is the purpose of the third experiment in this project.

Experiment II is a replication of an experiment conducted by Maltzman and his co-workers (Maltzman, Simon, Raskin, and Licht, 1960) in which a kind of nonspecific transfer of training was produced. This experiment introduces a particular training procedure which is employed in Experiment III in both its original and modified forms. The primary reason for the replication of this experiment is to try to get additional information on the nature of what subjects learned from the training procedure that mediated the transfer effects. The hypothesis is that subjects learned and/or utilized a strategy. Of course, this interpretation is different from that proposed by Maltzman, et. al., who operate in an S-R framework. The details of these matters will be discussed when the original research is reviewed in a following section.

In sum then, the aims of this research are (a) the refinement of a battery of insight problems for use in research on problem solving, (b) the administration as hints of the solution relevant properties of the elements in these problem situations to subjects in order to test the hypothesis that the method of property analysis is a heuristic, (c) the replication of an experiment by Maltzman, _et. al._, in order to get additional information on the nature of the knowledge that mediated the kind of nonspecific transfer effect they observed, (d) the training of various groups of subjects using the procedure employed by Maltzman, _et. al._, in both its original and in modified forms, and (e) the assessment of the effects of this training using the battery of insight problems as criterion tasks. These aims will be attained by means of three separate but related experiments.

In the interest of economy, the historical and theoretical literature that is relevant to and a background for the theory has not been presented here. The major traditions or significant works which have been influential in the evolution of the theory are these: Gestalt theory, especially as it is applied to problem solving and thinking by Wertheimer (1945); the work of Bruner, Goodnow, and Austin (1957) on concept attainment and attribute theory; information theory and computer simulation developments, especially as these are reflected or embodied in the works of Miller, Galanter, and Pribram (1960) and Newell, Shaw, and Simon (1958); the study of heuristics, especially Polya's (1945) important revival of interest in the study; Craik's (1943) hypothesis on the nature of thought; and Piaget's (1954) work on the construction of reality in the child. An earlier version of this theory along with a review of historical and theoretical background literature has been presented elsewhere (Daniels, 1961).

Chapter 2

Review of Relevant Literature

The empirical work that is directly relevant to this research is rather limited. This review will not be comprehensive but will contain representative studies conducted from several different points of view.

One class of experiments in training to facilitate problem solving consists of attempts to test the hypotheses put forth by Alex Osborn (1953). These pertain to the procedure called "brainstorming." Basically, there are three hypotheses or assumptions that underly this procedure, two of which have concerned investigations in the past. One is that postponement of critical evaluation during the brainstorming process will lead to the emergence of more good ideas, the second is that the greater the absolute number of ideas one thinks of, the greater will be the number of good ideas. The third assumption implicit in the procedure is that if the number of good ideas is increased for either reason, there will be a corresponding increase in the efficiency of the one solution the subject finally decides on.

Basically, the brainstorming procedure is a general strategy that Osborn assumes will be a heuristic that will lead to the invention or discovery of better problem-specific solutions. The first strategy, the suspended judgment one, according to Osborn's interpretation seems to have all the characteristics of a heuristic as this strategy has been defined above.

The strategy of thinking of as many ideas as possible on the assumption that the proportion of good solutions that occur will remain relatively constant is not as obvious a heuristic. The heuristic value of this strategy is tied even more closely than the first strategy to the assumption that if many good solutions are thought of, the subject will settle in the end for a better solution than he would otherwise.

The controlled experiments that have been concerned with Osborn's hypotheses have to do mainly with his first two assumptions. Christensen, Guilford, and Wilson (1957) studied the relationships between the number of responses produced and the successive increments of time in which they occurred in several creative thinking tasks. Among the tasks were two in which the instructions called for different kinds of titles for short stories. On one task, the subjects were instructed to "put down only clever titles," and on the other, to "put down all appropriate titles." There was no counterbalancing to control for possible practice effects. The evidence indicated that when subjects operate under the first instruction, they produced more high quality ideas than when they operated under the second instruction. This has been interpreted as evidence against the hypothesis. The major limitation of the study is the failure to counterbalance the receipt of the two tasks and this may account for the difference. In addition, to argue effectively that this is evidence against the hypothesis one would have to provide a good case for the assumption that instruction to put down all titles is equivalent to the brainstorming strategy and that the instruction to be clever is its opposite. It seems clear that the instructions that would logically be regarded as brainstorming would recruit different strategies than the instructions to be clever. The latter puts a premium on good ideas while the former implies that any old idea will do. In any event, this study is mainly significant in that it is the predecessor to a more carefully controlled one to be described later on.

A study by Meadow and Parnes (1959) at the University of Buffalo, attempted to evaluate the effects of a course at the University in creative problem solving. The course was based on the brainstorming procedures of Osborn. The hypotheses tested were that the course would produce significant increases in (1) the quantity of ideas for solving a problem, (2) the quality of ideas, and (3) three personality variables, need achievement, dominance, and self-control. The subjects who had enrolled in the course that was to be the training were matched with subjects taking other courses in the University on the basis of age, sex, IQ, and a vocabulary score. Both pre- and post-training tests were administered to the groups in their regular classes at the beginning and the end of the semester during which the training was administered. The control subjects received no special treatment.

The measures for quantity of ideas were Guilford's AC Test of Creative Ability which involves thinking of other uses for a common object, and a Plot Titles Test. The measures for quality of ideas were a second plot titles test, Guilford's Unusual Uses and Apparatus Tests, a second "other uses" test, and a modified version of the TAT.

Compared to the controls, the experimental subjects showed significant increments on both measure of quantity of ideas and on three out of five measures of quality. The experimental subjects also showed a significant increment in dominance as measured on the California Psychological Inventory Dominance Scale.

It is clear that the subjects who took the course produced significantly more ideas of good quality. What is not so clear is why they did. The problem solving course was an elective which would probably lead to a selection of subjects that the particular matching variables used would not control for. It is very likely that motivation to take the course in the first place would be associated with very important differences in subjects that would be difficult to account for by any matching procedure and that would no doubt lead to differences in performance on the criterion tasks even without the training. Secondly, the experimental subjects had thirty hours of constant pracitce with problems on which they might have developed heuristics without the training procedures employed. In addition, then, to the initial individual differences problem, there is a confounding of effects of the practice as compared to no practice and the brainstorming technique as compared to the natural strategies of control subjects. Consequently, the experiment tells us nothing for sure about the merits of the brainstorming method.

A second study by Meadow, Parnes, and Reese (1959) studied the effects of the instruction to "brainstorm" as compared with the effects of "nonbrainstorming" instructions. The subjects were trained in the brainstorming procedure and the same subjects were used in both conditions of the experiment in a counterbalanced design. In one case, they were told to "brainstorm" to your fullest ability; forget about quality entirely. We are going to count only quantity on this test. . . Quality is of no concern at all." In the other case, they were told, "Forget all about brainstorming. Strive completely for quality. We want to see how many good ideas you can produce in a certain amount of time. You are going to be penalized for any bad ideas. Any ideas rated as poor will be subtracted from your score. . ." In both cases, the subjects were given five minutes to think of other uses for a wire hanger and a broom, problems selected from Guilford's AC Test of Creative Ability.

The various responses were rated by trained raters separately for uniqueness and for value or usefulness and a score assigned by combining these ratings. A "good" response was one which met a particular criterion on the combined rating.

The major findings were that significantly more good solutions were produced under brainstorming instructions than under the nonbrainstorming instructions, and that significantly more good solutions were produced under the brainstorming instructions when they were given first than when they came after the nonbrainstorming instructions. These findings were interpreted as evidence for the hypothesis that brainstorming methods lead to an increasing amount of creativity on certain creative thinking tasks. In other words the results would seem to support the second hypothesis that suspending judgment while listing solutions leads to the listing of more good solutions.

There is a very plausible alternative interpretation of the results in this experiment that should be considered. That is, that the differences between the number of good ideas observed between brainstorming and nonbrainstorming conditions could be due to differences in the standard of judgment employed by the subjects and the raters. If a subject is more critical in his judgment of what constitutes a good solution than the raters are, then ideas he actually thought of but did not write down would have probably been rated "good" by the judges. In this case, the difference between the number of good solutions proposed by the subjects in two conditions would not be due to the superiority of the brainstorming method, but to the difference between the good-quality "thresholds" of the subjects and the judges. Whether a subject thinks of a solution and writes it down or thinks of it and does not write it down should make little difference in the quality of his final solution unless someone besides the subject is going to decide which of all the good solutions will be chosen for the final one. No doubt the reason why this factor was not appreciated by these investigators is that brainstorming is primarily a group method in which the group makes the decision about what is the best solution. While advocates of the method maintain that in principle there is little difference between group and individual brainstorming, carrying over the assumption that an idea must be expressed verbally or in writing to be considered in the final analysis could be very misleading. This would seem to be a very likely interpretation of the differences observed for the two kinds of instructions. However, it is not an insurmountable problem. It should be easy enough to compare the raters with subjects themselves with regard to their feeling for "good solutions."

If one considers all the limitations of these studies, there is not much conclusive evidence in them for Osborn's first two hypotheses and they provide no evidence at all on the third one--concerning the heuristic-value of the method. This assumes, of course, that heuristic-value is defined in terms of a particular solution decided upon rather than the number of good solutions proposed. Since neither Osborn nor the investigators who conducted these studies were operating in the present framework but rather in a system in which creativity is defined primarily in terms of the number of ideas in general or unusual uses in particular, this is not an indictment against them but a matter of point of view. However, it is clear that they are going to have to break out of the Unusual-Uses-as-a-criterion-measure circle eventually and begin to study the effects of treatments on insight problems. For this reason, they might profitably begin to study the ability of subject's to decide on a final solution as it relates to their ability to think of good solutions. In other words, they would do well to consider the heuristic-value of the strategies they are trying to teach as this has been defined here.

A second general class of experiments that is relevant to the present project was conducted by Iving Maltzman and his associates (1960). In the context of a behavioristic theory of thinking, they conducted a number of experiments in which they were concerned with the training of originality. They define "original thinking" as "behavior which occurs relatively infrequently." The basic assumption underlying their approach is that "if original behavior can be induced to occur repeatedly through some training procedure, it will increase in its frequency of occurrence in a new situation." (Maltzman, et. al., 1960, p. 236).

The first experiment in their series employed Maier's pendulum problem as a criterion on the assumption that what Maier regards as productive thinking is merely uncommon responding and, therefore, original thinking as it is defined in their framework. In this study, the subjects were given a screw driver and a piece of balsawood along with the string as materials. The experimenter read a list of unusual uses for each item. Maltzman, et. al., point out that none of the uses in the list referred to operations involved in the experiment. The control subjects had no treatment prior to receiving the problem. Both groups were finally given the pendulum problem with the screw driver and balsawood as materials. The experimental group solved the problem significantly faster than the control group. In subsequent replications of this basic experiment with modifications in the lists of unusual uses, the same results were found except that the significant differences held up for women but generally not for men.

The experimenters felt that the list of unusual uses (uncommon responses of the experimenter) read to the experimental subjects made them think more originally because original behavior that can be induced to occur repeatedly will increase in its frequency of occurrence in new situations. It should be noted first of all, that in this case, the subjects did not omit the uncommon responses at all, and therefore, the experimenter's uncommon responses would have to account for the superiority of the experimental group! Secondly, the uses suggested for the balsa wood and the screw driver have high coherence with the various properties such as weight that might be solution relevant and mere mention of the uses by the experimenter probably called the subject's attention to those properties. Since the control subjects did not have this "priming" experience with the materials involved in the problem, this would account for the obtained differences. This study proves nothing about training in originality or productive thinking unless it is that thinking about the materials in different ways (analyzing them) is a pre-condition for productive thinking.

The difficulties they experienced of working with the two-string problem made these investigators turn to other measure of originality already developed by others. They selected Guilford's Unusual Uses Test and a modified free association procedure in which the stimulus words are selected on the basis of restricted response hierarchies. The basic design of the experiments in this series involve giving the various experimental and control groups various amounts of free association experience. In the first experiment, a control group was given an initial list of twenty-five words to which they responded, then a second list of twenty-five words to which they gave free associations, and finally, they were given the Unusual Uses Test. The second list and the Unusual Uses Test were the criterion measures of originality. The first experimental group received the same treatment with one important difference. The initial list of twenty-five words was presented five times and the subjects were told to give a different response each time the same word reappeared. A second experimental group had this same treatment except that the experimenter said "good" following every fifth uncommon response. The control group and the two experimental groups were each subdivided with one subgroup of each major group being given the verbal instruction to try to be original and the other subgroups were told nothing. This instruction was given just prior to administration of the criterion tasks--not prior to the training.

The criterion scores for the subjects in this experiment were obtained by first determining the frequency with which the various responses to each word in the second list of twenty-five words occurred, assigning to each word a kind of "originality value" with the more uncommon responses having the lower values, and then obtaining a mean for each subject on the basis of his performance that reflected his originality. The criterion measure for the Unusual Uses Test consisted of the number of unique uses the subject offered with "unique" being defined as a use that occurs only once in the sample. The results of the experiment showed that both training and instructions to "be original" produced significant increases in originality on the free association test. The results on the Unusual Uses Test were ambiguous.

In an attempt to rule out as important the number of stimulus words presented, the number of times the subject responded, and the number of different responses evoked, another experiment was conducted that controlled for these variables. In this experiment, the same sort of groups were employed though without the instructions to be original. As before, the experimental group was instructed to give a different response to each presentation of the same stimulus word. The controls responded as before to the twenty-five words in the first list. Two other experimental conditions were added. For one of these groups, the subjects responded to 125 words, the same number of responses the original experimental group made except in this case none of the 125 words were the same. The second experimental group received the same treatment except that the words in their list were "low frequency" words as determined by the Thorndike & Lorge tables while the other group had high frequency words. Finally, a second control group was added in which the subjects were instructed to try to give the same response at each repetition of the words in the list and they received each of the twenty-five words five times just as the original experimental group did.

The results on the free association test showed that the three experimental groups did not differ significantly from each other and neither did the two control groups differ from each other. However, each of the experimental groups was significantly more original than each of the controls. On the Unusual Uses Test, the original experimental group did significantly better than all the other groups. The two new experimental groups did not differ from the standard control group but the control condition in which the subjects tried to give the same response to the repeated words, were significantly less original than each of the other conditions. It appears that the effect of having the subject give a large number of responses is about the same as having him give many different responses to a fewer number of words. This is the case on the free association test, but not the case on the Unusual Uses Test. Subjects who give different associations to the same word repeated several times do significantly better than all other groups on the Unusual Uses Test.

In another experiment, Maltzman, et. al., (1960) had the same standard condition for the control and the same experimental group which received five repetitions of the list with the instructions to give different responses to each word. A second experimental group was added in this study in which the subjects were given repeated presentation of items from the Unusual Uses Test in order to see to what extent the effect is material-specific. Six items were presented a total of six times with instructions to give different uses for each presentation of an item. Two other experimental groups were included in which there was a variation of what the subject was to do with the 125 pairs of words given them. The results on the free association test and the Unusual Uses Test indicated that the standard experimental group was significantly more original than the other four groups on both tests and the other groups did not differ significantly from each other. In this experiment, giving different uses for items was not as effective as training as free association to the same stimulus word a number of times.

They did one other study that should be mentioned. It was basically of the standard conditions described earlier but it included assessment at two different time intervals, one hour and two days. The results showed that the effects of originality training as described here persisted for at least two days. They conclude that this indicates that some kind of learning had taken place, implying that instructions that might produce temporary changes would not be some kind of learning.

These experiments were conceived in the context of a behavioristic theory of thinking and, of course, it is in this context that they are interpreted. They say the experiments pose two basic problems both of which involve the operation of reinforcement to produce the transfer effects observed. The first problem is "the nature or source of the reinforcement for originality." This is a problem, they say, because the training produced changes in behavior that are characteristic of learning, yet those changes occur in the absence of differential reinforcement by the experimenter. Maltzman, et. al., add that even though the experimenter did not reinforce the original response, the reinforcement was there. "Reinforcement was obtained, because the occurrence of any previously established intra-verbal association is self-reinforcing. As Thorndike put it: 'The mere occurrence of a connection strengthens it'. . . Originality is more reinforcing than commonplace responding." (Maltzman, et. al., 1960, p. 239) They go on to say that this self-reinforcement is probably less significant in producing an increase in originality during training than in the test situation because the instructions to the experimental group prohibit the repetition of the same response to a given word. This prohibition is enough to account for the increase in uncommonness of response to the same words. He argues that in addition to the instructions there is one other factor that contributes to the increase in originality during the training session. This is generalization of the reinforcement effects from the evoked responses to the still more uncommon responses in the same hierarchy.

The second problem the data raise for them concerns the increase in originality in the test situation where there is a new list of words in the free association test and the Unusual Uses Test which is still more different. They say this is the problem:

> The fact that the evocation of uncommon responses on one list of stimulus words facilitates the occurrence of original responses on a different list of words, and even more perplexing, on the rather different Unusual Uses Test. The problem is to account for the fact that reinforcement of one instance of original behavior increases the response tendency for other instances of such behavior under different stimulus conditions. A relatively nonspecific kind of transfer of training is induced. Without it, the facilitation of originality would not be possible. (Maltzman, et. al., 1960, p. 24)

They then proceed to make the following suggested interpretation. The intraverbal associations in an adult are enormously extensive and complex. Every verbal response is probably associated to some degree with every other one. The intraverbal associations between the common verbal responses are stronger than those between the common and the uncommon responses. Likewise, the association among uncommon responses are relatively stronger than between common and uncommon responses. "The evocation and reinforcement of uncommon responses will, through complex kinds of mediated generalization, therefore increase differentially the probability of occurrence of other uncommon responses even though they do not ordinarily occur to the same stimuli as the original reinforced responses." The same applies to the common responses. In addition to this, generalization of inhibition must take place in the same general way. This is Maltzman's, et. al., explanation for the nonspecific transfer effects obtained in his experiments.

This interpretation, while it may be consistent with S-R theory, seems inadequate. Can the theory developed in the first part of this report make better sense of the results? For purposes of this analysis, two questions must be answered. (a) What did the experimental subjects learn that mediated the nonspecific transfer effects? and (b) what features of the training procedure are responsible for that learning?

In the language of the theory described earlier, the subject already has a particular reality orientation in that he knows the state of the world at the time he receives the instructions. Furthermore, the words spoken by the experimenter activate the knowledge mechanisms the subject employs to think about the anticipated state: the state in which the subject himself will have spoken the first word that occurred to him upon the presentation of the stimulus word. It should be added that the usual subject unwittingly probably, concludes or assumes from these instructions that the word he responds with is to be related to the stimulus word in some obvious way. There is a discrepancy between the existing state and the anticipated one, and this gives rise to an objective to reduce this discrepancy. This objective is the major organizing factor in the person's subsequent thought and behavior though not the only one.

A careful considdration of the task reveals that it is like Maier's two-string problem yet different from it. If in Maier's problem, the subject had been told the general instruction that he would be required to bring two things together and tie them, and then had he been given a series of different situations, one after another, this would be like the association task. This means that in the association task the subject does not have his first specific objective until he has been given the first stimulus word and that each subsequent word is a new task with a new objective. Each specific objective is different from the previous ones, but the same in general.

When the subject hears the stimulus word, "pencil," he has his first objective which derives from the discrepancy between the existing state and the anticipated one. The word "pencil" immediately activates the knowledge system that represents pencil. The activation is generally synoptic and some other knowledge system is immediately recruited or activated by it, say the system that represents "lead." Lead would be a part of the larger structure that represents the whole pencil. The subject may respond by saying, "paper." This would occur because the knowledge systems that represent paper and pencils have an intimate involvement that accounts for the high coherence of one with the other.

It must be emphasized that many knowledge systems have high coherence with the structure that represents pencils. It is not being assumed that the knowledge system that has the highest coherence with the pencil system is always recruited when the pencil system is activated, though high coherence is clearly one of the factors that accounts for this particular organization of thought. The additional factor, of course, is the objective which recruits a strategy that is relevant to the existing and anticipated states. Without the influence of this objective, thought would run off strictly according to the degree of coherence between the knowledge systems in the person and there would be little likelihood that the response to the stimulus would be in a certain class.

This might be made clearer with another illustration. The usual example given is the situation in which the subject is told to get ready to add numbers that will be given him. The word "add" activates our "adding" strategy and the anticipatory state. The words "two" and "three" are then presented and the subject responds with "five." Without the influence of the objective associated with changing the situation from the existing one to a situation involving a sum, the subject might say "one" or "six" or "twenty-three," depending on which had the highest coherence with these knowledge systems.

In other words, as was the case with the two-string problem, the particular objective recruits a strategy that limits or defines the range of responses that are appropriate. While within that range, the knowledge system having the highest coherence with the pencil knowledge system is recruited, the major organizing factor is the objective and the strategy recruited by it.

This may seem like an overly complex analysis of the simple association phenomenon. However, the multiple-association situation is not always a matter of a simple association for the subject. With the later repetitions of each stimulus word, the subject often experiences a temporary stalemate. The task is then much more problematical. He finds it more difficult to attain the objective associated with each stimulus word. What does the subject do when he encounters such stalemates? Using the language of this theory, to think about what happens, especially in the stalemate situations, a more understandable rationale can easily be developed.

It seems reasonable that essentially the same sort of thing happens in this task as happens in Maier's two-string problem. The subject probably resorts to the use of certain strategies. If the subject either develops a new or utilizes an available strategy, and if he experiences the utility of the strategy in attaining his objectives on different stimulus words in the training list and on subsequent repetitions of the training list, he would be inclined to employ that same strategy on the criterion task.

Even on the Unusual Uses Test, when the subject encounters a temporary stalemate, the objective which is somewhat similar to that in the original task, would likely recruit the same strategy that had demonstrated efficacy in the past. This could be the major mediator of the nonspecific transfer effects observed in Maltzman's experiment.

A second point that should be noted is that most subjects probably do not accept at face value the justification Maltzman, et. al., gives for the experiment--that it is a test of reaction of time. If they do not, then perhaps they develop ideas about what they think the real purpose of the experiment might be and perhaps this affects their objective. In other words, it is possible that experimental subjects might begin to get the idea that the whole task is a test of their originality. If they conclude this, then the state they anticipate might be one involving an original response rather than just the first one that comes to mind and that seems to be related to the stimulus word.

It appears that there are alternative interpretations of what the subjects learned that mediated the effects observed in the original study. The second experiment in this project is a replication of the conditions that produced the non-specific transfer along with the necessary control conditions. The major purpose of the replication in this project is to see if additional information can be obtained that will make possible a more realistic explanation of the findings.

The experiment is of special interest also because of the training procedure employed. In the analysis made earlier, it was concluded that the conditions that must be met in order for a person to learn a new and/or utilize an available strategy are the following: the person must experiment a stalemate which demonstrates the inefficacy of the usual strategies,and he must experience the efficacy of the new strategy he uses for attaining a series of objectives. The multiple-association procedure seems to need both conditions to some extent. Furthermore, modifications of the procedure might be made which will increase the likelihood that a particular heuristic, such as the strategy of property analysis, will be employed when a stalemate occurs. The reasons then, for the effectiveness of the training procedure, are that it meets these requirements.

In Experiment III, both the original and the modified forms of the multiple-association procedure are employed as experimental conditions.

One final line of previous research was conducted by the author (Daniels, 1961). This involved teaching subjects a strategy called the "method of descriptive analysis." The strategy calls for the subject to describe the problem situation and the elements in it on the assumption that this procedure will have heuristic-value, that it will lead the subjects to think of solutions to the problems. The effects of the training were assessed by means of a series of perceptual tasks as well as some of the insight problems employed in the present research. Non-specific transfer effects that result from the training showed up mainly on those tasks that required the subject to "attain" or remember a visual display as in the familiar Embedded Figures Test. No effects were produced on the small battery of insight problems included in the assessment battery. Presumably, the reason for the failure of the training to produce effects on the insight problems was that the subjects had not experienced the utility of the method of descriptive analysis in attaining their objectives. The strategies apparently failed to acquire efficacy for the kinds of objectives that are associated with the insight problems.

Hypotheses

The first hypothesis is that the method of property analysis is actually a heuristic in that thinking of solution-relevant properties will lead subjects more readily to solutions to the problems in question. This hypothesis will be tested in Experiment I.

The second hypothesis is that what subjects learn from Maltzman's special training procedure that mediates the transfer effects observed in his research are strategies that prove efficacious during training and are then subsequently applied on the criterion tasks. Associated with this hypothesis is the assumption that subjects who receive the special training procedure adopt a new objective to be the original. Information that is relevant to this hypothesis will be obtained in Experiment II.

The final general hypothesis is that the strategy subjects learn or employ during the training procedure will mediate nonspecific transfer effects to a battery of insight problems. In Experiment III this hypothesis will be tested in various ways.

Chapter 3

Experiment 1

According to the analysis of the problem solving process made earlier, mature adult subjects in our culture possess sufficient knowledge systems to solve the insight problems but they often fail because when they experience a stalemate they either do not possess or they fail to utilize heuristics that will help them capitalize on their own natures to recruit and organize existing knowledge systems into the necessary combinations.

Furthermore, it was hypothesized (a) that a special training technique which is basically a multiple-association procedure will provide subjects with the experience from which they may learn and/or utilize a heuristic, and (b) that if subjects employ this heuristic they will be able to think of solution-relevant properties which will in turn lead them to think of a solution to the problem. This first experiment is concerned mainly with the second of these hypotheses. The major aim is to ascertain whether or not thinking of solution-relevant properties will in fact lead subjects to think of solutions to the problems. This will be accomplished by giving experimental Ss "hints" in the form of solution-relevant properties. In other words, the experiment is designed to find out whether or not the strategy of property analysis is a potential heuristic. If the hints suggest significantly more solutions to the insight problems, then the strategy of property analysis is at least a potential heuristic and there is good reason to believe that subjects can be taught to apply this heuristic and to be more effective as a result.

While this is the major aim of this first experiment, a second important end must also be accomplished before this and the subsequent experiments can be performed. The battery of insight problems employed in previous research must be developed and refined, and an analysis made of each problem in order to ascertain what properties appear to be solution-relevant.

In order to accomplish these aims, a search was first made of the problem solving literature and other sources for additional insight problems to be added to the original battery. Each of these problems was pre-tested on a number of individuals in order to assess their suitability for inclusion in the final assessment battery and in order to ascertain what properties of the elements seemed to be most relevant to the solution or solutions. Problems which met the following criteria were regarded as suitable for inclusion in the assessment battery: (a) at least some of the subjects in the sample could solve them within a few minutes, (b) the number of solutions proposed by subjects was quite small with a very few of such solutions being regarded as feasible by independent judges, (c) the solutions could be simply stated or written out by the subjects in a few lines, (d) the solutions tended to occur suddenly as a kind of insight, and (e) the problem could be prepared for presentation to the subjects in a paper-and-pencil form. Nine problems that met these criteria were finally selected.

By means of a post-solution interview with each pre-test subject, a general description was developed of what people tend to think about as they solve each problem. This analysis was made using the terms of the theoretical framework being employed in this project to think about the problem solving process. Out of this analysis came the identification of the properties that seemed to be most relevant to the solutions to the problem--and that also seemed most closely associated in the minds of the subjects with the principles underlying the solutions.

In the following section, each of the problems finally included in the battery is described along with the solutions regarded by the judges as feasible and the properties of the elements that the analysis revealed to be solution relevant. The paper and pencil form of this battery of problems is presented in Appendix A.

The Insight Problems

The coins problem. The major elements in this problem are a gallon bucket and a quantity of pennies. These elements are drawn for the subject above the instructions. The latter call for ascertaining how many pennies a bucket like that pictured might contain. The only restrictions are that the solution be arrived at without counting each penny individually and without using a regular coin counter. The subject is told that he may employ any other materials he might think of even though they are not shown in the drawing.

Several solutions to this problem were proposed by the subjects in the experiment, and in this case several were regarded by the judges as feasible. The most frequently proposed solution involves weighing a single penny, weighing all the pennies, and then dividing the weight of the one into the total weight. The solution-relevant property of the pennies in this case seems clearly to be weight.

The next most frequently occurring solution to this problem involves ascertaining how much water a single penny displaces, how much water all the pennies displace, and then dividing to find out how many pennies there are altogether. Volume would be the solution-relevant property of the pennies for this solution.

A third solution proposed occasionally by subjects in these experiments entails making a single stack of pennies ten high, stacking the remainder of the pennies in piles the same height as the first, counting the number of piles and multiplying by ten. The property that seems to be most relevant to this solution is the thickness of the pennies. In this solution, as well as the earlier ones described, the subjects assumed a uniformity among the pennies of the extent to which the specific value of each property applied.

Occasionally a subject would propose lining up a row of ten pennies end to end, lining up the remainder of the pennies in lines of the same length, counting the number of lines and then multiplying by ten. Here the relevant property is the diameter of the pennies.

Heart-bow problem. This problem, used by Ruger (1910) in his important work on problem solving requires the subject to separate two pieces of wire, one bow-shaped and the other heart-shaped. The subject must accomplish the objective without cutting the wire or unwiring the pieces. The elements in the problem are the heart and the bow. There are two solutions the judges regarded as feasible. The most frequently occurring solution involves bending the heart into a long thin loop and sliding it out _in toto_ through the small hole in the bow. To do this, the subject must capitalize on the maleability of the wire. Accordingly, maleability appears to be a property of the wire that is relevant to the solution.

The next most frequently occurring solution and perhaps the most elegant one involves inserting the rather long loop in the center of the heart into the small hole in the bow through which the other end of the bow extends, looping it over the end of the bow, and drawing it back out of the hole. A solution relevant property would appear to be the shape of the bow.

Oil in bottle problem. The elements in this problem are a large wooden barrel full to the top of oil, and a glass jar full of water. The barrel has a single, fairly small hole in the top. The subject must propose a solution to the problem of getting the jar full of oil. There are a number of restrictions that make the task appear to be impossible at first. The subject cannot move the barrel or damage it in any way, and he cannot use other materials in his solution. Only one solution proposed by the subjects in this research was regarded as feasible by the judges. This entailed inverting the bottle still full of water, inserting its neck into the hole in the top of the oil barrel, and waiting for the oil to change places with the water in the bottle. The solution-relevant property is the specific gravity of oil. The subject must see the relationship between the oil and the water with respect to which is heavier. Since some subjects may not know the semi-technical term, "specific gravity," the term "buoyancy" may be employed. The term "weight" might be solution relevant to the subjects, but since buoyancy more clearly implies a relationship between things, it would appear to be more likely to suggest the solution to the subjects.

Dime-quarter problem. The only elements the subject has to work with in this problem are a quarter and a single piece of paper which has a hole in the center exactly the size of a dime. The task is to pass the quarter completely through the hole in the paper without tearing or cutting the paper, and without changing or damaging the quarter. The only feasible solution proposed by the subjects in these experiments entails manipulating the paper so as to elongate to make oval the hole in the paper, for if the subject does not know that the paper is flexible enough to be bent in this way, he would not see this solution as feasible.

The beads problem. The elements in this problem are screwdriver, a needle, and a string of beads. The beads on the string are purple or white. A regular pattern of two purple then two white, two purple and two white, etc., is shown in the drawing of the beads. At one point on the string five white beads occur one after another. The subject's task is to think of a way to make the sequence regular through the whole string of beads. The subject is restricted from untying the string or damaging it in any way and to using only the materials specified in the problem. The only acceptable solution proposed by subjects in these experiments calls for breaking the excess beads with the screw driver, restoring the regular repeating pattern of two purple and two white beads. The property of the beads that is relevant to this solution is their brittleness.

Dime-in-the-bottle. The elements in this problem are a bottle with a dime inside and a cork in the top. The task is to get the dime out of the bottle without removing the cork and without damaging the cork or the bottle or the dime. No other materials may be used in the solution. The one acceptable solution involves pushing the cork down into the bottle, then shaking the dime out. Of course, to do this, the cork must be flexible. Flexibility is the solution relevant property of the cork.

Maier's two-string problem. In this problem, the subject is confronted with a picture of a room in which two strings are hanging from the ceiling. They are separated by a distance that makes reaching one while still holding to the other appear to be impossible. Included in the problem situation as presented to the subject is a person holding one string and reaching for the other and a pair of scissors. Using the scissors to cut down one of the strings is not allowed. The most frequently occurring solution involves tying the scissors to one of the strings and making a pendulum, then grasping the other string and waiting for the scissors to carry the second string within reach. A number of properties could possibly be solution-relevant. However, since the scissors must be employed as a pendulum bob and since most people know that a pendulum bob is designed primarily to augment the weight of the pendulum, weight would appear to be solution relevant and perhaps more likely to suggest the pendulum solution than other properties.

A property of the string that might be relevant to the solution and that might suggest the solution to some subjects is its flexibility. If the string were not flexible, one could not tie it to the scissors to achieve the pendulum solution. While it seems less likely to suggest the pendulum solution than the property weight, it could have some hint-value.

Occasionally, a subject would suggest that the person pictured in the problem remove some article of clothing such as his shirt or his belt and tie this to one of the strings in order to get the extension needed for him to reach the other string. A hint, in order to be effective for suggesting this solution would have to pertain clearly to the clothing. To hint by making reference to an item such as a belt would be hinting that some other element in the problem situation is relevant rather than the property of that element. This is another strategy that would be useful on the functional fixity type problems or for problems on which elements that are not obviously relevant are quite solution relevant. Since it is somewhat different from the "think of the properties" strategy that is the concern of this research, and since no property appears to be peculiar enough to these elements to suggest these solutions no hint was identified for them.

Suspended ring problem. The elements in this problem situation are a bottle with a cork in the top, and a ring suspended in the center of the bottle by a string attached to the cork. The problem is to make the ring drop to the bottom of the bottle without touching either the bottle or the cork and without damaging or changing them in any way. No restriction is made on use of materials that are not pictured in the problem booklet.

The most frequently occurring solution to this problem involved employing a magnifying glass to focus the rays of the sun on the string in order to burn it "in two." A number of properties might be relevant to this solution or might suggest it. The property that would appear to be most likely to suggest the solution is the combustibility of the string.

Occasionally subjects would propose using an extremely powerful magnet under the bottle in order to apply the necessary stress to the string to break it. While this proposal involves a number of unusual assumptions about the kind of metal in the ring and the strength of the string, the judges regarded it as a feasible solution. Since magnetism is generally associated with metal and since only a certain class of metals are affected by magnets, the property "metalic" seems likely to be relevant to this solution.

Mount the candle problem. The elements in this problem are a box of three ordinary candles, a box of thumb tacks, and a box of matches. The instructions call for a solution to the problem of mounting the three candles vertically (in an upright position) on the side of a wall composed of soft wood.

A number of solutions occurred quite frequently in this research. Perhaps the most frequently proposed solution and clearly the most elegant, involved attaching the boxes in which the candles appear to the wall by means of the tacks and then mounting the candles on the shelves thus created. This is the classical functional fixity problem. Since the subject must overcome the assumption that the boxes may serve only the "container" function, a hint in the form of a property may not be particularly suggestive of this solution. Since the strategy that concerns us in this research involves thinking of properties rather than obscure elements in the situation, no hint for this solution was given in the experimental situation to be described below.

A second solution to this problem involves sticking a thumb tack through the wick of each candle and into the wall. Another one involves thinning the candle at some point by carving off excess wax and then sticking the tack through it and into the wall. A third solution involves inserting half the head of one of the tacks into one side and half the head of another tack into the other side of a candle and then pushing these tacks into the wall. All of these solutions seem to involve the softness of either the candles or the wick. Hence, softness appears to be relevant to these solutions and could suggest any one of them if given as a hint or if thought of spontaneously by the subject.

A number of other solutions that judges regarded as acceptable were proposed by subjects in these experiments. However, so few of each was proposed that no attempt was made to ascertain the solution relevant properties for them for use in the experiment.

The second phase of work on this first experiment involved administering the assessment problems along with the solution-relevant properties as hints to different groups of subjects in order to ascertain whether or not providing the subjects with property-hints would facilitate their problem solving. Three groups were employed in the experiment. The subjects in Group I were given the battery of insight problems but received no hints. Subjects in Group II received the battery along with one solution relevant property typed under the problem. For example, for the coin problem, the subjects in this group received the problem with the words, "Hint: weight," typed under the instructions. For each problem, the property that was relevant to the most frequently occurring solution to each problem was provided as the hints for this group.

Subjects in Group III received the battery of insight problems along with a single solution relevant property for each problem. For those problems for which only one solution was considered acceptable by the judges, the same hint given subjects in Group II was provided. Where a problem had two or more acceptable solutions, the solution relevant property provided as a hint was either a property relevant to one of the less frequently proposed solutions or a different property that could have also been relevant to one acceptable solution to the problem that the subjects proposed. This means that for some problems, the hints for Groups II and III were the same.

Table I

The hints for the problems in the assessment battery and the various groups receiving them

Problem	Group		
	Group I	Group II	Group III
Count the coins	no hint	weight	volume
Heart-bow	no hint	maleability	shape
Barrel-oil	no hint	buoyance	buoyancy
Dime-quarter	no hint	flexibility	flexibility
Beads	no hint	brittleness	brittleness
Dime-bottle	no hint	flexibility	flexibility
Two-string	no hint	weight	flexibility
Ring-bottle	no hint	combustible	metallic
Mount the candles	no hint	softness	softness

Table I summarizes the various conditions of the experiment and the hints given each experimental group for the respective problems.

This design permits the assessment of the "hint-value" of the properties themselves, and the value of different properties as hints compared with the suggestions the problems as presented provide for the subjects. It also tests the proposition that subjects may actually know enough about the materials and may know the solution principle as well and yet not solve the problem because they do not think about the problem in a way that gives them access to this knowledge. It would follow from this that if subjects could learn a strategy for givin themselves hints--for gaining access to relevant knowledge--they might be better problem solvers as a result.

The hypothesis that subjects can be taught to give themselves hints is tested in Experiment III, to be reported later. This experiment bears on the feasibility of this more interesting possibility.

Subjects. The subjects for this first experiment were sixty volunteers, undergraduate, male college students from introductory psychology courses at Brigham Young University. They were randomly assigned to the control and experimental groups.

Procedure. An attempt was made to secure not only the solutions each subject proposed for each problem but the time required by each subject for each solution. The experimental procedure involved having all subjects spend three minutes thinking of solutions to each problem and then two more minutes writing down the solutions that occurred to them during the "think period." Each subject was provided with a card on which his number was printed. He raised the card whenever a solution occurred to him during the think period. The experimenter noted the time from the beginning of the think period at which the subject raised his card. During the two minute writing period, the subjects wrote down their solutions for which they raised their cards in the order that they thought of them. This arrangement made it possible for the experimenter to match the subject's record of his solutions in the text booklet with the times recorded for their occurrence by the experimenter. Data on both the sequence and the time the solutions were proposed was made available by this procedure.

In order to inform the subjects of this procedure, the following instructions were read carefully with them:

> We are attempting to pre-test a number of problems and an administration procedure for use in research to be done later on in problem solving. We are interested in both your solution and the time required for arriving at it.
>
> You have been given a problem booklet which contains nine problems and space for you to write solutions to these problems. You will notice that a card is attached to your problem booklet and it has printed on it a number which also appears on the booklet. Do not open the booklet until told by me to do so.
>
> I will allow you a maximum of 2-1/2 minutes "thinking time" on each problem. You will begin on problem number one when I give the signal to do so. Please spend the entire 2-1/2 minutes thinking about the problem and trying to figure

> out the best solution to it. Should you think of one solution, try to think of others as long as there is time left in the 2-1/2 minute period. When the 2-1/2 minutes are up, I will signal you to begin writing the solution or solutions you have thought of. You will have three minutes to write down the solution or solutions you have thought of. Do not go on to the next problem until I tell you to do so.
>
> Now, as soon as you get one idea for a solution, hold up the card you have been given in order that we may see the number on it. It is important that you do this as soon as you think of a solution but not before you think of it. Be sure I see you raise your card so that I can note the time. After raising your card, proceed to try to think of a second solution. If you succeed in thinking of a second way to solve the problem, raise your card again that I may note the time. After raising your card, proceed to try to think of a second solution. If you succeed in thinking of a second way to solve the problem, raise your card again that I may note the time. Continue in this manner until 2-1/2 minutes have elapsed. At that time, I will give you the signal to stop thinking of solutions and begin writing the solution or solutions thought of during the think period. If you thought of more than one solution, be sure to number them in the order in which they occurred to you. This is important in order for us to know which solution goes with which time you raise your card.
>
> Before we begin, let me stress that it is important to me that you be honest about reporting the time of your solution or solutions. Our interest is very impersonal. Your answer booklet is to be anonymous. I do not want you to write your name on any of the materials we provide you. You will notice that the number on your card also appears on the problem booklet. This will make it possible for me to relate the time information to the solutions proposed. This is one of my main interests along with the solutions themselves. This provision divorces you as a person from the solutions you give and should give no one any reason to do anything but report times honestly. I trust you to do this. Are there any questions?

These are all the instructions the control subjects received. Subjects in the experimental groups received these instructions plus the following additional information about the hints for each problem.

> One thing more: A hint has been provided in the form of a single word. The hint has something to do with one of the elements in the problem situation. The word is typed on each problem sheet under the instructions. Are there any questions about this hint?

In addition to these instructions, all groups were cautioned against divulging any information about the problems to anyone else until all the experiments were completed lest they happen to talk to someone who serve as a subject later on. A commitment to refrain from discussions of the experiment or the problems with others who had not participated was secured from all subjects in all groups.

Table 2

Analysis of variance for the acceptable scores of the no-hint, single-hint, and multiple-hint groups

Source	df	ss	ms	F
Groups	2	57.63	28.81	5.23*
Error	57	314.30	5.51	
Total	59	371.93		

*p less than .01

Results for Experiment I

The raw data secured from each subject consisted of (a) proposed solutions for each of the insight problems in the assessment battery, and (b) the time that elapsed between the signal to begin and the moment when the subject's first acceptable solution was proposed. When a subject wrote a somewhat sketchy description of his proposed solution, a judgment had to be made regarding its acceptability. Accordingly, each protocol was scored independently by two judges who did not know from which groups in the experiment the solutions came. Inter-judge agreement was consistently above 95% in all the experiments reported here in which scores on the insight problems were involved. Those instances of disagreement that did occur were discussed and resolved to the satisfaction of both judges. Of course, no judgment was involved in the scoring of the time data.

Using the total number of acceptable solutions as the criterion scores for the subjects in each group, a simple analysis of variance was run in order to ascertain the level of significance of the differences that occurred in the number of acceptable solutions proposed by the respective groups. The resulting F ratio was 5.23, with 2 and 57 degrees of freedom. This is statistically significant beyond the .05 level of confidence. The summary table for this analysis is presented in Table 2.

The means which the over-all F test indicates are significantly different from each other are presented in Table 3. A test of significance of the differences between the respective group means was made using the t test. The experimental subjects, those in groups II and III who received the hints, had an average of 6.00 and 5.25 acceptable solutions respectively. Each of these means is significantly greater than the mean of 3.65 for the control subjects who received no hints. The difference of .75 solutions between the means of the two experimental groups is not statistically significant even though the mean for the Single-Hint group is slightly larger.

Table 3

The mean number of acceptable solutions proposed by the no-hint, single-hint, and multiple-hint groups

Group	Mean Number of Solutions
I. No-Hint	3.65
II. Single-Hint	6.00
III. Multiple-Hint	5.25

The time allotted the subjects on each problem was two and one half minutes, or 150 seconds. If a subject failed to propose an acceptable solution in this amount of time, he was given a score of 150 seconds for that problem. Since there were nine problems, if a subject failed to propose an acceptable solution to any of the problems, he would receive a score of 1350 seconds. The criterion score for each subject was the total number of seconds that elapsed between the signal to begin and the occurrence of the first acceptable solution on all problems combined. A high score means, of course, that the subject either proposed a fewer number of acceptable solutions than a subject who obtained a low score, and/or he was slower in arriving at his solutions than a subject with a low score.

Using this time score as a criterion score, a simple analysis of variance was run in order to ascertain the level of significance of difference observed between groups. The resulting F ratio was 4.65, with 2 and 57 degrees of freedom. This is statistically significant beyond the .05 level of confidence. The summary table for this analysis is presented in Table 4.

Table 4

Analysis of variance for the time-to-first-solution scores for the experimental and control groups

Source	df	ss	ms	F
Groups	2	324,219.15	162,109.57	4.65
Error	57	1,987,099.40	34,861.39	
Total	59	2,311,318.55		

The time score means for the respective groups in the experiment are presented in Table 5. A test of the significance of the differences between the respective group means was made using the t test. The mean time of 17.84 minutes before the first acceptable solutions proposed by control subjects is significantly more than the mean of 14.91 minutes for the single-hint group. Likewise, the mean of 15.81 for the multiple-hint group is significantly less than the control group mean. The means for the experimental groups did not differ significantly from each other.

Table 5

The means of the time-to-first-solution scores for the experimental and control groups

Group	Mean in Seconds	Mean in Minutes
I. No-Hint	1,017.60	17.84
II. Single-Hint	896.20	14.94
III. Multiple-Hint	948.65	15.81

These differences in time to first solution are consistent with the results of the analysis based on the number of acceptable solutions. All group differences are in the same direction in both analyses and in both cases, the experimental groups differed significantly from the controls but not from each other. The number of acceptable solutions score appears to be the best one to use in connection with the assessment battery, however. In the first place, the time data are more difficult to obtain in the experimental setting than the number of acceptable solutions. In the second place, since it is concerned only with time to the first acceptable solution, the time score loses information that pertains to acceptable solutions subjects propose after the first one. Accordingly, in all subsequent experiments conducted in this series, the criterion score employed for the insight problems is the number of solutions proposed by each subject in the time allowed.

Discussion

The results of this experiment confirm the hypothesis that providing experimental subjects with hints in the form of solution-relevant properties will facilitate their problem solving. It is also assumed that the results add an increment of confidence to the analysis made in this study of the problem solving process. Apparently, providing solution-relevant properties as hints is effective in increasing the number of solutions proposed because solution-relevant properties give rise to solution-relevant relationships which have high coherence with the principles on which the solutions are based. In other words, the strategy of thinking of properties of elements in a problem situation is a potential heuristic in that it may help one capitalize on his own nature to recruit and organize existing knowledge systems in new combinations.

Of course, telling a person what the solution-relevant properties are is obviously much simpler than training him to think of properties on the assumption that he will hit upon the solution-relevant properties and in turn be led to think of a new problem specific strategy. Providing a person with the kinds of training experiences that will not only teach him how to do this but that will also allow him to learn that this heuristic has considerable efficacy, is a much more difficult undertaking. Whether or not the special training procedures discussed in general will serve this purpose remains to be seen in Experiment III.

Chapter 4

Experiment II

The purposes of this experiment are (a) to replicate the basic experiment by Maltzman, et. al. (1960) on training in originality, and (b) to attempt to gather additional information that will bear on the appropriateness of their interpretation of the findings. The hypotheses are (a) that essentially the same result will be obtained in this experiment as was found in the original, and (b) that the additional information that will be secured will lend support to the interpretation that subjects who experience the special training condition adapt a new objective to be original, and employ strategies that prove efficacious in attaining the new objective during training, and then apply these strategies on the criterion tasks. In sum, it is hypothesized that the major mediator of the non-specific transfer effects to the Unusual Uses Test are those strategies that are recruited by a new objective to be original that experimental subjects adopt during the course of the training.

In order to attain these objectives, considerable clinical analysis preceded the actual replication of the original experiment. A number of subjects were given the basic training procedure that produced the most profound effect in that experiment. This was described earlier as a kind of multiple-association procedure. In this procedure, the subject is given a list of 25 words--this is the training list--one at a time and at five second intervals. (See Appendix B for all the training and test lists employed in this research). He is instructed to respond to each word with the first word that is suggested by the stimulus word. At the beginning of the training session, the following instructions were read to the subjects.

> This is a test of reaction time. I want to find out how quickly you can respond to words. It is not a personality test or a test of intelligence. Try to respond to the word that I say to you with the first word that comes to mind and respond as quickly as possible. Write your answer in the appropriately numbered space. Write quickly because there will not be much time between words. The particular word that you give is not as important as your speed of responding. There are no right or wrong responses except that I don't want you to give the same word more than once. Remember, respond as quickly as you can with the first word that you think of. Are there any questions?

Procedure. While there are several conditions in the experiment, the basic condition that is of central interest in this replication involves the following. When the training list has been presented once, the subjects are instructed that the list will be read again and that they are to respond again with the first word that comes to mind but not with the same word they responded with the first time through the list. The words are read four more times with the same instructions for multiple but restricted associations to them. This condition or treatment will be referred to hereafter as the "same-stimulus-different-response" condition.

Following the training experience, the subjects are given a new, different list of 25 words--the test list--with instructions to respond to each word with the first word that occurs to them.

Pre-test subjects given this training procedure were carefully questioned regarding what they thought the experiment was actually about, if this affected how they went about the task, and what strategies they adopted or found themselves using. The preliminary inquiry revealed that most subjects interviewed seem to do considerable thinking about the experiment, its purposes, and the like, even while they perform what is called for by the instructions. Furthermore, they often adopt strategies for performing the task and/or can verbalize the strategies they seem to be employing during the course of the experiment. For example, many subjects doubted that the avowed purpose of the experiment--to test reaction time--was the actual purpose the experimenter had in mind. Some subjects even felt that the whole procedure had something to do with how original they could be. Others thought the purpose was to reveal something about their personalities. With regard to the strategies employed, some subjects maintained that they tried to give opposites , some tried not to give opposites. Others adopted or found themselves using a strategy of responding to his own previous response rather than to the stimulus word repeated by the experimenter. Some said they would use this method in order to develop a "chain of associations." This would, of course, lead to greater originality or uncommonness of response among subjects on subsequent repetitions of the same list.

Rarely did the subjects report actually thinking what to do on the first time through the training list. Words seemed to arise spontaneously when the subject first heard the word. The response seemed to be more a mechanical reaction the first time through the list. On later repetitions of the training list, however, subjects report that they had to "apply themselves" to the task in order to think of different words with which to respond. They reported that it was during the later stages of the experiment when the spontaneous responses failed to occur that they began "trying different methods" for thinking of new associations.

Of course, this preliminary analysis of what seemed to be happening as reported by the subjects themselves is anecdotal and qualitative. Accordingly, based on these preliminary findings, a questionnaire was designed that would make it possible to get some quantification of these findings. This questionnaire was developed to be administered immediately following the experiment. Some of the questions are open-ended. Even with these, responses can be classified and counted. The following questions were included in the post-experiment questionnaire.

1. The instructions indicated that this was an experiment in reaction time. Did you at any time during the experiment suspect that this was not the real purpose of the experiment? If your answer is "yes," did you have any ideas as to what the real purpose of the experiment might be? If so , please write in the space provided what you thought the purpose might be, however vaguely you suspected it.

2. Did you develop, adopt, or find yourself using any particular method or methods for thinking of new associations as the task got more difficult in the later stages on the first list? If your answer is "yes," please describe the method or methods you used.

3. Note that there were two different lists of words. The first list of 25 words and then a second list of 25 words. Did you deliberately try to perform differently on the second list than you did on the first? If your answer is "yes," please indicate in what respect you tried to perform differently on the second list than on the first.

4. If you found yourself performing differently, though not necessarily deliberately, please describe in what respect you performed differently on the second list than on the first.

5. Did you learn anything during the multiple association part of the experiment that seemed to affect the way you went about the Unusual Uses Test? If your answer is "yes," indicate what it was you learned and how it affected your approach to the Unusual Uses Test.

In addition to making the analysis just described during the preliminary phase of this experiment, the instructions employed by Maltzman, et. al., in the experiment to be replicated in this research were pre-tested in order to insure their precise execution in the control and experimental groups of the experiment proper.

The experiment entailed four different training conditions. All subjects in all conditions received the training list of 25 words at least once. This occurred at the very beginning of the experiment in all cases. Instructions given the subjects prior to the training have already been presented at the beginning of this section. All groups then received the second list of 25 words--the test list--preceded by the following instructions.

> Now we will go through a new list of words. This list will be presented only once. You are to respond to each new word with the first word that comes to mind as quickly as possible. Do you have any questions? Ready... begin.

Following the test list, all subjects received the Unusual Uses Test. (See Appendix C). This task requires the subject to list as many different or unusual uses for a common object as he can think of. The objects used in the task for this experiment were an automobile tire and an ordinary key. Finally, all subjects except those in the control group received the post-experiment questionnaire described earlier.

In sum, the control subjects received the 25-word training list once, the 25-word test list once, the Unusual Uses Test, and finally, the post-experiment questionnaire.

One experimental group received the 25-word training list once, then the same list five additional times with instructions to respond on each subsequent presentation of a stimulus word with a different response. They then received the test list, the Unusual Uses Test, and finally, the post-experiment questionnaire. This treatment is the "same-stimulus-different-response" condition.

A second experimental group received the 25-word training list followed by five different, additional 25-word lists to which they responded in the same way. Following these six different lists, these subjects were given the test list, the Unusual Uses Test, and the post-experiment questionnaire. This treatment is referred to hereafter in this report as the "six-list condition."

The third experimental group received the training list once, the same as all other groups. They were then instructed that they would receive the same list five additional times and that they were to respond to the stimulus words on each subsequent presentation with the same responses they gave the first time through the training list. Because of the repetition called for, this treatment is referred to as the "monotony condition." Following the repetition of the training list, these subjects received the test list, the Unusual Uses Test, and then the post-experiment questionnaire.

The prediction was that essentially the same results would be obtained on this replication as were found in the original experiment. The condition that was most effective in producing increases in originality in that experiment was the same-stimulus-different-response condition. The next most effective training procedure was the six-list condition. The monotony condition tended to produce less original responses on the test list than even the control group. There was the additional expectation in this experiment that the post-experiment questionnaire would yield information that would aid in deciding among alternative interpretations of the results.

Subjects. Subjects for this experiment were 140 male and female students from introductory psychology courses at Brigham Young University. These subjects were randomly assigned to the four groups with 35 subjects in each group. The reason for including both male and female subjects is that subjects in the original experiment consisted of both males and females.

Results of Experiment II

Since this experiment was a replication of the basic experiment conducted by Maltzman and his associates, the same or nearly identical scoring and analysis procedures employed by them were also employed in this research. The raw data consisted of (a) the first response of each subject to each stimulus word presented in the pre-test or training list, (b) the first response of each subject to each stimulus word in the Test List, (c) the responses of each subject on the Unusual Uses Test.

The criterion scores for each subject that were derived from the above data were obtained by means of the following procedure. Every response given by all subjects to each word was recorded on a master list and the frequency of occurrence of each response word was tabulated. For example, the stimulus word "pencil" produced 55 "pen" responses, 50 "paper" responses, 26 "lead" responses, and so on. Using the master list, each subject's responses to the stimulus words in the Training List were assigned values that corresponded with the frequency of those responses in the larger population. If a subject gave "pen" as a response to the word "pencil," his "pen" response would be assigned the value of 55, and so on with all twenty-five of his responses. A low originality score reflects high originality in the subject's responses.

Table 6

Means and standard deviations for the various groups on the originality scores for the training list

Group	Mean	S. D.
Same-Stimulus Different Response	47.60	8.05
Six-List	50.80	9.94
Monotony	49.74	10.43
Control	51.26	8.67

Results on the Test List. Using each subject's originality on the training list as a criterion score, a simple analysis of variance was run in order to assess the significance of differences that appear between the originality means of the various groups. The purpose of this analysis was to see if the various groups differed significantly in originality before they had experienced the training procedures. The F ratio for this analysis is 1.04, with 3 and 136 degrees of freedom. This is not statistically significant. The means and standard deviations for the respective groups appear in Table 6.

Bartlett's test for homogeneity of variance was applied to the data and the variances were not significantly heterogeneous.

A simple analysis of variance was then run on the originality scores for the test list. The resulting F ratio is 9.51, with 3 and 136 degrees of freedom. The summary table for this analysis appears in Table 7. The differences among the means are statistically significant well beyond the .05 level of confidence. This finding indicates that after the training procedures had been administered, the various groups differed significantly in originality on the test list.

The means and standard deviations for the respective groups are presented in Table 8. The t test was employed to test the significance of differences observed between the means of the various groups.

Table 7

Summary table for the analysis of variables
of originality scores on the test list in Experiment II

Source			
Treatments	3	2949	983.00
Within	136	14051	103.32
Total	139	17000	

The same-stimulus-different-response condition subjects were significantly more original on the test list than all of the other groups, but none of the other groups were significantly different from each o[illegible].

Table 8

Means and standard deviations for the
various groups on the originality scores for the test list

Group	Mean	S. D.
Same-stimulus-different-response	28.26	8.59
Six-list	35.49	10.58
Monotony	37.91	10.46
Control	40.60	10.30

These findings are slightly different from those obtained by Maltzman, et. al., in that they found the six-list condition to produce significantly more originality on the test list than the monotony or control treatments. They found that the six-list condition did not differ significantly from the same-stimulus-different-response condition. While these data indicate that the six-list condition subjects tended to be more original on the test list, they were not significantly more original than the controls. In summary, then, the conclusion that the same-stimulus-different-response procedure produces a marked increase in originality on subsequent associations tasks is supported by the replication though the six-list condition failed to produce the effect observed in the original experiment.

Results on the Unusual Uses Test, three different scores were developed from the raw data obtained with the Unusual Uses Test. Because of the differences in the size of the sample between the original experiment and this replication, a slight change was necessary in the method of arriving at this score.

One originality score was derived by exactly the same procedure used to obtain the originality score in the association test described above. A master list of uses was developed from the raw data showing the frequency of each of the uses proposed by the population of subjects. These frequencies were assigned to the uses in each subject's protocal, added to yield an overall originality total, and then divided by the number of responses to yield a "mean originality score."

A second originality score was derived from the data. After the frequencies from the master list had been assigned to each use in each subject's protocol, the number of uses each subject proposed which occurred less than 20 times in the population were counted. This is simply the "originality score." Maltzman's originality score was the total number of responses that occurred only once in the total population. It differs from this originality score, then, only in minor ways.

A third score was derived from the raw data. This score is the total number of uses proposed by a subject for all objects in the Unusual Uses Test. This is a fluency score. Maltzman, et. al., also secured a fluency score by counting the total number of non-unique responses, exclusive of the unique responses. Their score differs a little from the fluency score employed in this analysis, in that it does not include the unique responses, only the common ones.

An analysis of variance was run on the mean originality scores from the Unusual Uses Test. The resulting F ratio is 6.43, with 3 and 136 degrees of freedom. The summary table for this analysis appears in Table 9.

The F ratio is statistically significant well beyong the .05 level of confidence.

Table 9

Summary table for the analysis of variance of originality scores on the test list in Experiment II

Source	df	SS	MS
Treatments	3	1692	564.00
Within	136	11543	84.87
Total	139	13235	

The means and standard deviations for the respective groups appear in Table 10. The t test applied to the various differences between these means shows that the same-stimulus-different-response condition produced significantly greater originality on the Unusual Uses Test than did either the monotony or the control treatments. The difference between the means for the same-stimulus-different-response condition and the six-list condition was not statistically significant nor was the difference between the monotony and the control group.

Table 10

Means and standard deviations for the various groups on the mean originality score for the Unusual Uses Test

Group	Mean	S.D.
Same-stimulus-different-response	26.37	7.29
Six-list	29.00	8.38
Monotony	34.46	11.75
Control	34.31	8.28

The simple originality score--the number of uses each subject proposed that occurred fewer than 20 times in the total population--was also employed as a criterion score on the Unusual Uses Test. When these scores were subjected to an analysis of variance, an F ratio of 10.20 was obtained. With

3 and 136 degrees of freedom, this is statistically significant beyond the required .05 level of confidence.

An examination of the various means for the respective groups reveals essentially the same pattern as that found in the analysis made of the mean originality scores. Subjects who received the monotony condition and the subjects who were in the control group had practically identical means when this score was used as a criterion. The t test revealed that both the same-stimulus-different-response subjects and the six-list subjects were significantly more original than either the monotony or the control subjects. The means and standard deviations for these groups appear in Table 11.

Table 11

Means and standard deviations for the various groups on the simple originality score for the Unusual Uses Test

Group	Mean	S. D.
Same-stimulus-different response	15.09	5.18
Six-list	13.20	5.08
Monotony	9.46	3.78
Control	10.43	3.99

When the fluency score is employed as a criterion, the resulting F ratio for the analysis of variance is 11.05 with 3 and 136 degrees of freedom. This is statistically significant far beyond the .05 level of confidence. The means for the respective groups bear essentially the same relationships with each other as were observed in the other two scores just discussed. The differences between the various groups that are significant are the same differences that were significant with the other originality scores on this test.

In sum, according to all three measures of originality, the monotony condition and the control condition produced essentially the same results while the same-stimulus-different response condition produced considerable increases in originality and the six-list condition was next in order of influence in this respect. These findings are generally consistent with the results of the original experiment except that on the Unusual Uses Test, the six-list treatment did not produce significant greater originality than the monotony or the control treatments.

Apparently, the three measures of originality employed in this analysis are quite highly correlated. For purposes of future research, then, one might want to employ the fluency score which is by far the simplest to calculate. However, while the scores are highly correlated in this study, other kinds of experimental treatments might produce vast differences in originality as measured by these different scores. Hence, which score is employed as a criterion would depend to a large extent upon the nature of the training and the purposes of the experiment.

Results on the Post-Experiment Questionnaire. While the results of the replication are generally consistent with the original findings, in themselves they give no reason for choosing among alternative interpretations as to what might have mediated the transfer effects. The questionnaire was designed to provide additional data from the subjects that might be useful in this respect. Specifically, the results of the questionnaire should provide some basis for choosing among the following alternative interpretations: (a) the transfer effects resulted from a complex kind of mediated generalization; (b) the transfer effects may be due in part to subjects in the more original groups suspecting more often that the training procedure was a test of originality and then acting to be more original; and (c) the transfer effects were mediated by some strategy or strategies the subjects learned or begin to utilize in the process of encountering temporary stalemates during the training. The last two or combinations of them resulted from the analysis made using the theory described in Chapter I of this report and constitute the hypothesis of the experiment. The first statement represents the hypothesis proposed by Maltzman, et. al. to account for the findings.

The questionnaire was not presented to the control subjects since they received the training list only once and then the criterion tasks. Questionnaire data are available for the three experimental groups. Table 12 contains the frequencies of responses of subjects in the various groups to the questions in the post-experiment questionnaire.

Consider first the evidence relative to the suspected purpose of the experiment. It is apparent that the large majority of subjects in all three groups suspected that the purpose of the experiment was not to test the reaction time of the subjects. It is also clear that of those who did suspect the intent of the experiment, a majority in each group also had an idea as to what the real purpose might have been.

Table 12

The number of subjects in each experimental group who chose the alternative answers on the post-experiment questionnaire

Questions	I-6-list yes	I-6-list no	II-1-list yes	II-1-list no	III-Monotony yes	III-Monotony no
Did you at any time during the experiment suspect that this (reaction time) was not the real purpose of the experiment?	32	3	28	7	28	7
If your answer is "yes," did you have any idea as to what the real purpose might be?	24	8	23	5	20	8
Did you develop, adopt, or find yourself using any particular method for thinking of new associations as the task got more difficult in the later stages?	26	9	28	9	12	23
Note that there were two different lists. Did you deliberately try to perform differently on the second list than you did on the first?	5	29	9	26	10	25
Did you learn anything during the multiple association part of the experiment that seemed to affect the way you went about the Unusual Uses Test?	10	25	17	18	11	24

When the suspected purposes of the experiment reported by the various subjects in the three experimental groups were classified, the responses fell into several groups: (a) a test to diagnose personality, (b) a study of thought processes (c) a study of originality or creativity, (d) a study of reactions that occur to certain words, (e) a study of memory, (f) a study of recurring reactions, and (g) to assess vocabulary. The number of subjects in the respective groups who reported these suspicions was roughly proportional. About 25 per cent of the subjects in each group felt that it was a test of originality or creativity.

The hypothesis that the differences between groups in the amount of originality is due to the fact that subjects in the more original groups suspected more often that the training procedure was a test of originality and, therefore, tried to be more original, does not hold up since (a) there was a small number in each group who had such a suspicion and (b) roughly the same proportion in each group had such a suspicion.

There is one category in which the various groups did differ. All six subjects who reported suspecting it was a test of memory came for the "monotony" condition. This is understandable since that condition required the subjects to remember the responses they gave the first time through the list in order that they could give it on subsequent repetitions of the stimulus word.

Consider, then, the data that are relevant to the hypothesis that subjects learned a strategy for dealing with temporary stalemates in problems of this general kind and that this mediated the observed transfer effects. In the monotony condition of the experiment, 28 subjects reported that they developed, adopted, or found themselves using a particular method for thinking of new associations.

The item in the questionnaire that bears on this hypothesis was this: "Did you develop, adopt, or find yourself using any particular method for thinking of new associations as the task got more difficult in the later stages?" In the six-list group, 26 subjects reported that they did while nine reported that they did not. In the same-stimulus-different-response group, 28 subjects reported that they did while nine reported that they did not. In the monotony condition, where subjects gave the same response to the same stimulus words as they recurred, 12 subjects reported that they developed, adopted or found themselves using a particular method while 23 reported that they did not. This is a suggestive finding that becomes more important when the nature of these methods is considered.

Table 13 contains the methods subjects reported employing and a breakdown of the number of subjects in each group reporting use of each method. Ten subjects in the monotony condition reported the synonym-antonym pattern while only two reported other patterns. Likewise, the six-list sybjects who reported their method said they tended to try to give synonyms and/or antonyms practically always. Only four subjects in the six-list group reported any other method. The same-stimulus-different response subjects who had to respond six times with different responses to the same words reported using the synonym-antonym method only twice and 13 other methods. Several subjects in this group reported following out a line of thought and nearly the same number reported responding to their own prior associations. These two methods are in some sense the same.

Table 13

Methods subjects in the various groups reported using to think of associations

Method	Groups		
	Same S Diff R	Six-List	Mon-otony
Thinking of synonyms and/or antonyms	2	22	10
Thinking of properties of objects		1	
Thinking of things learned in other classes		1	
Relating words to everyday events	1	1	
Thinking of associations to my own prior associations	6		1
Looking around the room for ideas	1		1
Associating the idea to a field where it fits	1		1
Thinking of the locations of things	2		
Thinking of what objects do or result in		1	
Thinking of adjectives and verbs	1		
Thinking of rhyming words	1		
Thinking of familiar objects	1		
Relating words to origins	1		
Following out a line of thought	7		
Thinking of products associated with objects	2		
Thinking of past experience with objects	1		
Tried to think of odd things	1		

In either case, they are methods that would lead to more remote associations than synonym-antonym method.

There is an interesting feature of these reports that suggests another possible interpretation or a way to elaborate the original hypothesis. Notice for example, the strategy of "responding to one's own prior associations," or "looking around the room for an idea that something in the room might suggest" violates in some sense the implication that seems to be inherent in the instructions--to respond with a word that bears a reasonably close relationship to the stimulus word. It could be that most subjects unwittingly assume at the outset of the experiment that the experimenter intends for the response word to bear some obvious kind of relationship to the stimulus word. This, of course, would be a part of the definition of the anticipated state imposed on the subject by the experimenter. However, in the process of performing the training task, it seems to become apparent to the subject that this is an unwarranted assumption since the only responses the subjects seem able to come up with are more remote and less obviously related to the stimulus word.

If this same-stimulus-different-response training procedure actually leads the subject to revise his anticipated state, then he would experience a different discrepancy between his present state and his anticipated one. In other words, he would have a different objective, that of responding to the stimulus word with any word that bears even a remote relationship to it. If he adopted a new objective, then this objective would surely recruit different strategies. While these strategies may prove efficacious on the training procedure, they would not be the sole mediators of the transfer effects since the objective that recruited them is also produced by that training procedure.

It could be, then, that rather than suspecting that the experiment is a test of originality and then adopting being original as his objective, the subject develops a different objective about which he is not likely to report since he unwittingly arrived at the assumption on which the new objective is based. This different objective then recruits different strategies. These strategies may prove efficacious and be recruited again when the same objective recurs, but if this analysis is correct, the strategy by itself is not the sole mediator of the transfer effects observed in the experiment.

The synonym-antonym method reflects an assumption of a relatively close relationship between the stimulus word and the responses of the subjects. The fact that the synonym-antonym method was reported infrequently by the same-stimulus-different-response subjects, and that 13 other methods were reported suggests that the initial assumption they must also have made underwent a change as the training procedure progressed. Keep in mind that this finding pertains to the effects of the training on the test list. Additional evidence for this interpretation will be presented when the results of the post-experiment questionnaire pertaining to the Unusual Uses Test are examined.

In sum, then, there appears to be evidence in these data to suggest that subjects who experienced the same-stimulus-different-response condition tended to revise their assumption about the instructions and consequently adopted a new objective for the task. The old objective and the one adopted and maintained by the control subjects was, in effect, that the subject is to give a response to the stimulus word, but that the response need not bear a close relation to the stimulus word. Practically any response would be appropriate. The strategies that are recruited by this objective are those listed in Table 13, plus other subjects may have failed to report. The synonym-antonym method was recruited repeatedly by the control subjects in order to attain the objective of producing more closely related responses.

The post-experiment questionnaire also required the subjects to indicate whether they deliberately tried to perform differently on the test list than on the training list. Actually, this question turns out not to yield much useful information because of the fact that subjects tend to use the same strategy in the second list that they employed in the first. The question would have been more useful had it called for a comparison of method used "the first time through" the first list and the first time through the test list. While this kind of question would probably call for a judgment the subjects would not be able to make very easily, the kind of information such a question calls for would be more useful for deciding what the subjects learned by the training procedures that might have mediated that fairly specific transfer effects to the test list.

Now, if the interpretation proposed here of what the same-stimulus-different-response subjects learned that mediated the transfer effects to the test list has merit, then the next problem is explaining how this could mediate the nonspecific transfer effects observed on the Unusual Uses Test. It seems reasonable to assume that the Unusual Uses Test is like the association task in the initial assumption the subjects unwittingly make with regard to the objective. That is to say, even as the subjects initially assume that the response to the stimulus word should be closely related to the stimulus word in the association task, even so, they initially assume that the uses they are to list for the objects in the Unusual Uses Test are also to be more or less conventional uses that are realistic and practical. If a training procedure leads to a change in this assumption, then his objective is different and the strategies recruited by these objectives are different. It seems reasonable that a subject who has rejected the assumption of a close relationship between the stimulus word and the response word and adopted a liberal interpretation of the instructions would also undertake the Unusual Uses Task with a similar liberal interpretation of the instructions. If this is true, then he would begin by giving uses for the object that were not really practical or realistic. Of course, these are the kinds of uses a subject must list in order to receive a high originality score on this task.

If we can accept this possibility, then the subject who has had this "loosening" experience will adopt as his objective the listing of any kind of uses, even ridiculous ones. This objective recruits strategies that are appropriate to it with the result of greater uniqueness of response. These strategies may have been learned by the experimental subjects in the training task, or they may have been recruited for use in that task as a result of a temporary stalemate, their efficacy increased, and then used subsequently on the Unusual Uses Test. In either case, the revised assumption, the accompanying objective, and the recruitment of strategies for thinking of more remotely related responses would appear to mediate the non-specific transfer effects.

The final question in the post-experiment questionnaire yields information that is only slightly more helpful. The question is this: "Did you learn anything during the multiple-association part of the experiment that seemed to affect the way you went about the Unusual Uses Test?" This is a difficult question for the subjects to answer, it turns out, since they have not taken the Unusual Uses Test before and cannot, therefore, make a very useful judgment on how they might have performed differently following the training experience.

Table 14

What subjects in the monotony condition reported in response to the question as to what they thought they learned in the training condition that might have affected their Unusual Uses Test performance

On different objects, I was able to use the *same* use (italics mine)
Each person has a different background and experience
Some words frustrated me in finding different words
Some things really have only one good common use
Really many stupid word associations are possible
Just to give more than just stock responses
Couldn't think of any new uses after a while
Tried to think of funny things to write because it was a funny test
I don't have a very good imagination
Kept thinking of the first use. I couldn't get it out of my mind
Used "opposites" in Unusual Uses Test

While there is a question, then, about the subject's ability to make a realistic appraisal on the matter when he had not taken the Unusual Uses Test under normal conditions, there may be some merit to a consideration of the responses of subjects to this last question in the questionnaire. Thirty-eight of the 105 subjects in these three groups indicated that they thought they performed differently on the criterion task. Eleven of these subjects were from the monotony condition. The response of monotny subjects to the request that they write down the ways in which they performed differently are presented in Table 14.

An examination of these responses reveals that most of them are merely interpretive statements or observations the subjects had made about the Unusual Uses Test and/or the training procedure. Some of the responses are consistent with the hypothesis that these subjects were operating on the assumption that their responses should be restricted to reasonable, practical uses. Examples are "On different objects I was able to use the same use," "Kept thinking of the first use. . . I couldn't get it out of my mind," and "some things really have only one good common use." These statements suggest that the subjects were pretty well stuck with trying to think of realistic and practical uses.

In the same-stimulus-different response condition, there was a different flavor to the responses of the subjects to this part of the questionnaire. The responses of subjects in this group appear in Table 15. There are seventeen

Table 15

What subjects in the same-stimulus-different response condition reported in response to the question as to what they thought they learned in the training that might have affected their performance on the Unusual Uses Test

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I did think of some unusual uses
Started me thinking of new ways to attack the old subject
It was a method of making people improve their thinking power
Tried to remember what I had used them for or seen them used for
Thought of associated words for some and these led to uses
Tried to think of as many different ways a word can be described
Tried to write anything that came to my mind (two subjects)
Answers got more ridiculous. . . Actually one could do anything to the listed object
Wanted to write down what came to my mind and not what the actual use was
I learned how many associative uses some objects have and how we can be creative in the uses if we let our minds wander
Learned of associative uses in certain areas
Tried to use the same methods and approach and comparison
Difficult because of many ideas in the first part. I was used to rapid thinking
Associated area and object to a minor extent
Learned to think of different objects representing the same words

---

responses in this group. Some of them are interpretive like most of those in the control group. However, there are evidences that these subjects, even though they did not know what the Unusual Uses Test would have been like under normal conditions, thought they had learned something from the training procedure that affected their performance on this criterion task. For example, the subject who reported that the uses got more ridiculous and that "actually one could do anything to the listed objects," clearly was operating on the assumption of a liberal interpretation of the instruction. This subject very likely had as his objective the listing of such impractical and ridiculous uses. Control subjects appear not to have felt such responses are appropriate. Another subject in this group reported that he "learned how many uses some objects have and how we can be creative in the uses if we let our minds wander." This "mind-wandering" strategy is very like the "follow-out-one-line-of-associations" strategy used by subjects in this group on the training task. A third subject in this group reports trying to "use the same methods" in the training and criterion task. These and similar responses by subjects in this group lend support to the hypothesis that they had a rather liberal interpretation of the objective and that the strategies recruited by this objective in the training session tended to be applied on the criterion task.

Perhaps the final question would have been more useful had it called for the subject to report the strategy he used on the Unusual Uses Test rather than how the training seemed to affect his performance on that task. Then a comparison could have been made of his Unusual Uses Test strategies and the strategies he reported employing in the training task. Furthermore, more subjects would probably have given answers to this final question.

However, they do lend support to the conclusion that experimental subjects developed a new objective during the training which in turn recruited new strategies for thinking of remote associations, and that this carried over to the criterion task, giving the experimental subjects a more liberal interpretation of the objective that fostered the listing of impractical and somewhat unrealistic uses.

A word should be said about the validity and usefulness of a subject's report of what he was doing, trying to do, and the like. In the theory developed earlier, consciousness is basically an awareness on the part of the subject of his own cognitive processes. This means that the subject must have developed special knowledge mechanisms that he employs to think about the behavior of other knowledge mechanisms in the system--about his own thought. While subjects are certainly not always aware of what happens in their knowledge systems and they are never aware of all that happens in them, he is a kind of an observer of some of their behavior. His report is regarded as pretty good evidence that something like what he reports was actually going on in his cognitive structures. One must take care to guard against accepting his explanations for the behavior of his knowledge mechanisms and against assuming that he always reports these behaviors as he experiences them. However, if one regards the subject's phenomenal report with due caution it can be an important source of information on what happens when he solves particular problems. This is a possibility the behaviorists tend to ignore. Without considering such evidence, they will probably have a difficult time characterizing in any detail the "complex kind of mediated generalization" they postulate to account for nonspecific transfer of training.

Chapter 5

Experiment III

The purpose of this experiment were (a) to provide subjects with training experiences that are designed to help them learn a strategy for thinking about the elements in a problem situation in a way that will facilitate their problem solving, and (b) to assess the transfer effects of this training on the battery of insight problems evaluated in Experiment I and on the Unusual Uses Test. Since the results of Experiment I showed that the strategy of thinking of properties of the elements in a problem situation is a potential heuristic, it follows that training procedures which teach subjects this strategy may facilitate their problem solving. A number of important assumptions underly this hypothesis. The first is that the training procedures to be employed will in fact teach subjects the strategy in a way that will lead to its utilization in the transfer task. A second assumption is that subjects who utilize the heuristic will eventually hit upon the solution relevant properties of the elements in the problem situations.

Procedure

Six different treatment groups were included in this experiment in order to evaluate various forms of the training procedure. All subjects in all groups received (a) the battery of insight problems, described and evaluated in Experiment I, immediately following the administration of the training procedures; (b) the Unusual Uses Test described earlier and used in Experiment II; and (c) a post-experiment questionnaire that was designed to get information regarding what the subjects thought about various aspects of the experiment. The only ways in which these groups differed had to do with the treatment given them prior to the administration of the assessments instruments.

Four of the groups received basically the same treatment as the four groups described in Experiment II. However, in this experiment, all stimulus words in the training lists were nouns that designate physical objects. (See Appendix B) The lists employed in Experiment II consisted largely of both nouns and adjectives. The reasons for this change in the constitution of the training list are (a) that the elements in the insight problems are physical objects, and (b) some of the training conditions call for thinking of the properties of the objects the words in the training list design.

Group 1. Subjects in this group received no training, only the battery of insight problems and the Unusual Uses Test. This is the control group and they received the treatment given control subjects in Experiment II.

Group 2. Subjects in this group received six different training lists, all with the same instructions: to respond to each word with the first word that comes to mind. This is the six-list condition described and discussed in Experiment II.

Group 3. Subjects in this group received the single 25-word list six times with instructions to respond with a different response each time the stimulus word recurred. This is the same-stimulus-different-response condition that produced the most profound effect in the originality of the subjects in Experiment II.

Group 4. Subjects in this group received the training list with special instructions which limited their responses to properties of the objects designate by the words in the list. The following instructions were read to these subject prior to the initial presentation of the training list.

> This is a test of reaction time with restricted response. I want to find out to what extent time pressure affects your response output. I am going to read a list of words to you and you are to respond to the words as quickly as you can. The words will be names of particular objects. The responses you are to give are the properties of those objects. For example, if I say "pencil," you might respond by writing the word "yellow" or "color." Write your response as quickly as you can because I will give another stimulus word rather soon after the first one. There is one other restriction on your response: do not list the same property twice. Give a different property for each object. Are there any questions?

Following the first presentation of the list, the following instructions were read to these subjects prior to each subsequent repetition of the list.

> Now we will go through this list again. It will be presented in the same way as before. You are to respond to each word with another property of the object the word designates. Be sure not to give the same property you responded with before. Are there any questions?

This condition will be referred to hereafter in this report as the "property" condition.

Group 5. Subjects in this group received the same treatment as subjects in Group four plus special instructions on how to go about thinking of properties of the objects when the task becomes more difficult in later repetitions of the training list. Prior to the initial presentation of the training list, these subjects received the same instructions as subjects in Group four along with the following additional note.

> One other thing before we begin: I am going to suggest a method by means of which I want you to think of properties of the object I name. The method involves first imaging what the object looks like, and then describing it to yourself. By this means, you will be able to think of properties since properties are words we use to help describe things. For example, if I give the word "pencil," you would immediately imagine a pencil and then start to describe it. The words you use to describe it will be properties such as "yellow," or "color." This method of thinking of properties is called the "method of descriptive analysis." Try this method even though to begin with, it may be difficult to call up an image to describe.
>
> Let me review. I am going to read a list of words which designate physical objects such as "pencil." You are to respond as quickly as you can with the first property of the object named that comes to mind. You are to try to imagine what the object looks like and then describe it to yourself. The words you use to describe it should be properties of the object such as the color of the pencil. The color of a pencil might be thought of easily if you imagine what a specific pencil looks like. Respond as quickly as you can since there will not be much time between words. If you do not think of one before I give the next word, skip to the next one. Are there any questions?

Following the first presentation of the training list, subjects were instructed in the same way as subjects in Group four. They were told to respond with properties and to avoid giving the same property again when the stimulus word recurs. Because of the fact that these subjects are instructed on a special strategy, the treatment will be referred to hereafter as the "methods" condition.

Group 6. Subjects in this group received the initial 25-word training list with the usual instructions to respond with the first word that occurred to them. Prior to the five subsequent repetitions of the training list, they were instructed to respond with the same word they gave the first time they hear the word in the initial presentation of the list. This is the same condition given one group of subjects in Experiment II and that was described earlier as the monotony condition.

Subjects. Subjects for this experiment were 153 lower-division male students from introductory psychology courses at Brigham Young University. These subjects were randomly assigned to the six groups in the experiment with approximately 25 subjects in each group. Male subjects were used in order to reduce the heterogeneity among subjects that is often a source of difficulty in studies of this kind.

Results of Experiment III

Primarily because of the length of time required for administration of the training procedures, the battery of insight problems, and the Unusual Uses Test, the number of insight problems employed in this final experiment was reduced from nine to six. The problems included in this final battery were the coins problem, the oil-in-the-bottle problem, the dime-quarter problem, the beads problem, Maier's two-string problem, and the suspended ring problem. The criterion score on this battery was the total number of acceptable solutions to these problems. The same criteria were employed for scoring the solutions in this experiment as were employed in Experiment I described earlier. Scorer reliability was consistently above 95 per cent agreement.

A simple analysis of variance was run on these scores in order to assess the significance of differences that appear between the mean number of acceptable solutions proposed by the subjects in the various groups. The F ratio for this analysis is .63 with 5 and 147 degrees of freedom. This is not statistically significant at the required .05 level of confidence.

It should be noted that the assumption that the distributions created by counting the number of acceptable solutions form an interval scale is not really defensible and that the appropriateness of a parametric test would ordinarily be questionnable. However, there is evidence that analysis of variance loses little of its effectiveness when various assumptions on which it is based are not strictly met.(Lindquist, 1953).

The training procedure employed failed to produce the effect that was anticipated. Apparently, either the hypothesis has no merit or else one of the other assumptions made along the way was not defensible. In an attempt to ascertain which assumption or assumptions might have been unwarranted, the raw data were examined in considerable detail. A count was made of the number of unacceptable solutions proposed by subjects in the various groups. The mean number of unacceptable solutions to the various problems was calculated and there were rather large differences among group means. When the total number of unacceptable solutions is employed as a criterion score and submitted to an analysis of variance, an F ratio of 4. 07 is obtained. This is statistically significant. Inasmuch as there were minor but not significant differences between groups when the number of acceptable solutions were considered as criterion scores, an analysis was made of the scores created by counting the total number of solutions proposed by the subjects in the various groups, whether these solutions were regarded by judges as acceptable or unacceptable. This will be called the fluency score. When these scores are submitted to an analysis of variance, the resulting F ratio is 6. 03, with 5 and 147 degrees of freedom. This is statistically significant well beyond the required . 05 level of confidence. The summary table for this analysis appears in Table 16.

Table 16

Summary table for analysis of variance
of fluency scores for various groups

Source	df	SS	MS
Treatments	5	97. 42	19. 48
Within Groups	147	474. 68	3. 23
Total	152	572. 10	

The means and standard deviations for the various groups are presented in Table 17. The _t_ test was employed in order to ascertain the significance of observed differences between these means. The results of the analysis revealed that the same-stimulus-different-response treatment produced the greatest number of solutions, both acceptable and unacceptable. The mean for that group is significantly larger than all other groups in the experiment except the properties group. The next most effective treatment as far as this particular criterion is concerned is the properties treatment. The mean for subjects in the properties group is significantly larger than for the control group, the six-list group, and the monotony group. It is not significantly larger than the method group. Other differences were not statistically significant.

Table 17

Means and standard deviations of the fluency scores for the various groups on the insight problems

Groups	Means	S. D.
Control	5.76	1.29
Six-list	6.28	1.08
Same S-Different R	8.13	1.42
Properties	7.48	2.09
Method	6.72	1.74
Monotony	6.22	1.73

It appears, then, that the conditions which require the subjects repeatedly to give a different response to the same stimulus and that, therefore, lead the subjects to experience many temporary stalemates, are the most effective conditions in the experiment. Actually, though the properties treatment tended to produce significantly more fluency in solutions to the insight problems, subjects found the training procedure very difficult. Perhaps more training with this condition would have yielded greater returns than more training on the same-stimulus-different-response condition without the restriction to give properties as responses. In any event, though subjects in the properties condition had difficulty with the training task, they did produce significantly more solutions as a result of the training than the control, the six-list, or the monotony subjects.

What has been said of the properties condition is even more true of the methods condition. Subjects receiving that treatment complained that they were not given enough time between stimulus words to employ the method recommended for thinking of properties. They reported that with more time they might have been able to apply the strategy. Perhaps a training procedure in which more time is allowed between stimulus words during the first times through the list and gradually less time on subsequent repetitions of the list, would teach the subjects how to employ the strategy more effectively. In the present experiment, the assumption that the training procedure would teach this method was apparently not warranted.

Discussion of Insight-Problems Results

While there was no significant differences among the various groups on the number of acceptable solutions, the finding that the fluency of the various groups was different as a result of the training, is very consistent with the interpretation developed to explain the results of the replication of the original experiment by Maltzman, _et. al._ The evidence obtained in that experiment seemed to support the conclusion that subjects in the same-stimulus-different-response condition started the training task with the assumption that they were to respond with words that were closely related to the stimulus word, but that as the training continued, they revised their conception of what they were to do. The new assumption appeared to be that they could respond with practically any word even if it is only remotely related to the stimulus word. This change in assumption was accompanied by a change in the objective the subjects were trying to attain. The different objective of producing practically any response, no matter how remote its relation to the stimulus word, recruited a variety of strategies that were designed to help the subjects bring about the anticipated state of affairs. The fact that subjects in this condition were significantly more original in Experiment II on the test list and on the Unusual Uses Test was explained by saying that the new test list and also the Unusual Uses Test instructions were interpreted liberally in accordance with the assumption that any kind of response will be acceptable. Presumably, also, the objectives that resulted recruited again the strategies that were most efficacious in the training task. The mediator of the nonspecific transfer effects, then, would be the new assumption with the new objective that results from it and the strategies that were most efficacious during the training.

If this interpretation is valid, then, it is reasonable to assume that this same mediator would have to account for the findings being discussed here. The finding is, in short, that the subjects who experienced the most effective training procedure tend to produce significantly more solutions even though they were not necessarily acceptable according to the criteria set up by the judges in the experiment. The solutions proposed tended to be very unrealistic and impractical according to the judges' criteria. The explanation is, in effect, that the insight battery became another test of originality just like the Unusual Uses Test. The same mediator of transfer effects to the Unusual Uses Test mediated the transfer effects observed in the insight battery. One might even score the insight problems using the same procedures as were employed to score the Unusual Uses Test. Both a mean originality score and a simple originality score could be computed. The total number of unacceptable and acceptable solutions proposed for the problems in the insight battery is basically the fluency score as it was applied to the Unusual Uses Test in Experiment II.

It would appear, then, that subjects in the effective training conditions carried over the more liberal interpretation of the instructions with the accompanying objective to produce solutions that are not screened, so to speak, for acceptability. It is also likely that they employed on the insight problems the strategies they found efficacious in the training procedure and that, at least for the properties condition, this was probably the method of property analysis.

The results tend to confirm the original hypothesis in one sense, that a strategy mediates the transfer effects, but more important than this, they demonstrate in addition the extremely important role of the unwitting assumptions people make about what is expected of them. The assumptions which subjects seem to make at the beginning of the training procedures employed in this research clearly have to do with the subject's anticipatory orientation. Essentially, it sets limits on what he defines as his objective.

It should be noted that this change in assumption the experimental subjects experience results in an objective that is reminiscent of Osborn's brainstorming principle of suspended judgment. The difference is that while these subjects are proposing solutions uncritically, they are not doing so with the additional objective in mind of going back later to critically compare their solutions in order to arrive at a single final one. An important issue in problem solving is the study of the processes involved in making critical and effective evaluation of proposed solutions as these processes relate to the processes involved in thinking of such solutions. If the standard of acceptability of solution employed by the judges in this research is an adequate criterion, Osborn's hypothesis that quantity breeds quality is not substantiated by the experiment. Furthermore, the training procedures employed, while they may help subjects produce more solutions, do not teach subjects how to evaluate a solution. Of course, in problem solving, the workability of the final solution is the major criterion for productive or creative thinking. Hence, while the training procedure tended to lead subjects to produce more solutions, in the final analysis it can hardly be said that the training facilitated their problem solving.

One of the important implications of this finding is that research which employs the Unusual Uses Test as a criterion tends to imply that the productive and creative thinking of subjects has been increased when the subjects are able to produce more unusual uses. This implication claims too much. The insight problems in the battery employed in this research all have one or at most a few solutions that are really workable according to the limitations imposed in the problem. A training procedure that will produce significantly more acceptable solutions to these problems would be much more interesting than the procedures that will lead merely to greater fluency in which realistic standards for solution-evaluation are pretty much abandoned. For this reason, the battery of insight problems employed in this research would appear to be superior to the Unusual Uses Test and an excellent criterion task for use in research on instruction and training in problem living.

Another important implication is that the unwarranted assumptions that psychologists have recognized as important for some time deserve much more attention than they have had. What is needed, perhaps, more than added attention to them, is a theory of knowledge which deals in a meaningful way with the unwitting conclusions people make as they go about the enterprises of their lives. The theory presented in an oversimplified form in this report defines an assumption as a conclusion a person makes, wittingly or otherwise, about the state of the world or himself. One never procedes without making an assumption, i.e., without a constructed representation of the world, this idea is built into the assumption of a constant reality orientation.

Unusual Uses Test Results

Three different originality scores were employed in order to assess the effects of the various training procedure on the Unusual Uses Test. These are the same scores that were employed in Experiment II. The first is the mean originality score which is derived by (a) ascertaining the frequency of each respons in the population of subjects, (b) assigning these frequency values to each subject's response, and then (c) adding these values and dividing by the number of uses each subject proposed. A high score means low originality. The second score is simply the "originality score." It was the total number of uses each subject proposed that occurred twenty times or less in the total population of subjects. Finally, a fluency score was derived which consisted of the total number of responses, both common and uncommon, that each subject proposed.

A simple analysis of variance was run using the mean originality score as a criterion. The resulting F ratio is .73 with 5 and 147 degrees of freedom. This is not statistically significant. When the same kind of analysis is made using the simple originality scores as a criterion, the resulting F ratio is 1.37. This is not statistically significant either. Finally, an analysis of variance on the fluency score produces an F ratio of 1.30. Neither is this statistically significant.

Discussion of Unusual Uses Test Results

These findings are not consistent with the results presented and discussed earlier on the effects of the training procedure on this task. One would expect to find significant differences between the respective groups in the degree of originality.

Table 18

The means for the various originality scores for experimental and control conditions of Experiment II and Experiment III

Condition	Experiment	Originality Score		
		Mean Orig	Simple Orig	Fluency
Same-stimulus-different response	II	26.37	8.69	15.09
	III	30.80	6.63	13.08
Six-List	II	29.00	7.11	13.20
	III	28.28	6.60	12.96
Monotony	II	34.46	4.63	9.46
	III	30.22	6.33	12.26
Controls	II	34.31	4.63	10.43
	III	32.00	4.72	10.36

One might argue that having the subjects work on the insight problems between the training and the presentation of the Unusual Uses Test either had a dampening effect on the performance of experimental sbujects or else facilitated the performance of control and/or monotony subjects. There is a way to, at least, get an idea as to whether one or both of these effects could have occurred in this situation. This involves comparing various originality scores of the subjects in Experiment III with the same scores of subjects in Experiment II who received the same training procedures that were followed by the Unusual Uses Test. Table 18 contains the information that is necessary to make this comparison.

Consider first the same-stimulus-different-response subjects in the two experiments. The mean of 30.80 is much larger than the mean of 26.37 and represents less originality for subjects in Experiment III. On the simple originality score and on the fluency score as well, subjects in Experiment III were less original than subjects in Experiment II. This would suggest that if the battery of insight problems had an effect on the Unusual Uses Test performance of the subjects in this condition, it would have been a dampening effect.

An examination of the means in the two experiments for the subjects in the six-list condition reveals relatively little difference. However, there are larger differences between the originality means of subjects in the monotony conditions of the two experiments. This time, subjects in Experiment III have scores that reflect greater originality than that exhibited by their counterparts in Experiment II. As was the case with the same-stimulus-different-response condition, the differences for all three originality scores are in the same direction. This would suggest that if the interpolated battery of insight problems had an effect on the originality of these subjects on the Unusual Uses Test, the effect was facilitative. There appears to be relatively small differences between the means of the control groups in the respective experiments.

These results are somewhat perplexing in that if there is an interpolation effect, it would have to have affected the same-stimulus-different-response subjects in just the opposite way to the effect it would have on the monotony subjects. Such an interaction effect is not easily explained. A possible reason for the facilitating effect of the insight battery on the monotony subjects is that the interpolated activity served to provide some variety to the subjects which they welcomed and which may have led to a liberalizing of their assumption about what would be acceptable on the Unusual Uses Task. In other words, the interpolated activity might have counteracted the monotonous effect of repeating the same word over and over upon the presentation of the stimulus word.

It is possible that the interpolated insight battery might have affected the same-stimulus-different-response subjects in an opposite way. A reason for such a reversal in these subjects, if in fact the interpolated battery has anything to do with it, is not at all obvious.

A post-experiment questionnaire that was administered to all subjects failed to yield information that would shed light on the failure of the training to produce more originality in the Unusual Uses Test. One other possible hint comes from the fact that the training and assessment procedures were all administered in the same session which was relatively long and tiring. Since the Unusual Uses Test came at the end of the session, subjects may have become more homogeneous in the commonness of their responses as they anticipated finishing the session.

While these after-the-fact explanations are mainly suggestive at this point, they could be empirically tested more directly in future research.

Chapter 6

Conclusions and Implications

The research described in this report concerns the general problem of nstruction or training. More specifically, it has to do with the production by raining and the assessment of nonspecific transfer effects. The primary bjectives of the project are (a) to further develop a battery of insight problems or use in this project and in other problem solving research, (b) to replicate n experiment in training in order to ascertain just what subjects might have earned from the special training procedure that could mediate the nonspecific ransfer effect observed in that experiment, and (c) to attempt to teach subjects strategy that will mediate nonspecific transfer effects, not only to the usual ind of criterion task, but to the battery of insight problems that is developed n this research.

A theory of knowledge and instruction was presented in summary form. sing this theory, answers to the following questions were proposed: (a) What s the nature of the knowledge that mediates nonspecific transfer effects of the ind observed in the experiment to be replicated and of the kind expected in the esearch reported here? and (b) What conditions must be met in order for a erson to acquire such knowledge?

Using the language of the theory, a description was made of the problem olving process with emphasis on why a person in our culture who can fully nderstand a solution to an insight problem when he hears it can still fail to hink up the solution himself. To begin with, a person has a problem when he as an objective but no strategy that is effective in attaining it. In such situaions, the person experiences a temporary stalemate. Whether or not he ucceeds in thinking of a solution to the problem depends to a large extent upon hat he does when a stalemate is encountered, when failure is first implied. f course, some subjects tend to give up right away while others have other esources at their disposal. Most subjects continue to try to think of a soluion, at least for a while. What they do when they encounter a stalemate is dopt a new intermediate objective which recruits a new strategy. This may lso fail and the process may be repeated. Eventually, if the new objectives hey adopt and the strategies recruited by these objectives fail to yield a soluion, subjects will give up the attempt to solve the problem.

What subjects do, then, when they encounter a stalemate and are threatened with failure is to adopt a new objective. There are actually two kinds of alternative objectives. On the one hand, an objective may have to do specifically wit the problem or some arrangement of elements in the problem situation. In such cases, the objective and the strategy it recruits are problem-specific. On the other hand, the new objective may be to try a new approach to thinking up a specific solution to the problem. This objective is more general and it recruits a general kind of strategy called a "heuristic." Whether a subject adopts a new problem-specific objective, or adopts a more general one of starting anew on a different task depends among other things on the severity of the stalemate. In general, recourse is not taken to heuristics until the problem-specific strategie that are most relevant have been evaluated and fail to produce the solution.

The implication of this conclusion is that if one is interested in producing nonspecific transfer effects, then it would appear that one approach would be to design training procedures that will teach heuristics--general strategies that help one capitalize on his own nature in order to think up new ideas for solving problems. If he is interested in helping subjects learn strategies that will be useful in fairly specific kinds of problems, then he should design training procedures to teach problem-specific strategies.

What conditions must be met in order for one to acquire such knowledge? The theoretical analysis revealed that an objective and the strategy it recruits will be utilized again when the solver has experienced a stalemate and then succeeded in attaining the objective because of the efficacy of the strategy in question. In other words, subjects will learn a new strategy if existing strategies result in stalemates and if the new strategy is tried and found to be efficacious.

Maltzman, *et. al.*, report an experiment in which they employed a training procedure that appears to meet these requirements. The procedure is a restrict multiple association task in which subjects first respond to words in a 25-word list with the first word that occurs to them. The same words are then presented to the subjects a second time with instructions to respond with a different word. Subjects receive the same list a number of times with the same instructions to give different responses on each subsequent repetition of the words in the training list.

The original experiment revealed that subjects who experience the training list tend to be more original on a 25-word list, and more interestingly, on the

Unusual Uses Test of originality. While transfer to the test list is quite specific, transfer to the Unusual Uses Test appears to be more nonspecific.

Using the theory outlined in this report, a careful clinical analysis was made of the learning and performance processes subjects in pre-experiment sessions appear to experience during the training task. This analysis revealed that the association task, though not a problem to begin with, soon becomes a problem when the subject gets to the later stages of the procedure. They very frequently encounter real difficulty in thinking of new associations to the stimulus words once the more obvious ones are given. It appears that the subjects adopt a particular objective at the beginning of the task and that the objective recruits a strategy. When these strategies fail and a temporary stalemate is experienced, what do subjects resort to in order to think up new associations? They appear to adopt a new objective which recruits a new strategy for solving the problem.

The procedure is introduced to the subjects as a study in reaction time. The analysis suggests, however, that experimental subjects might get the idea from the nature of the task that it is not a reaction time study, but that it is a test of originality. If they interpret the task in this way, then the objective they adopt when they encounter a stalemate would be to think of more original responses. This new objective would recruit a different strategy.

What might this strategy be like? The task is such that when the subject hears the stimulus word on subsequent repetitions of the list, he is likely to think of the first word he gave and then to go on from that to some other acceptable response. Should he continue to do this, he, in effect, learns a way of following a line of thought with each subsequent idea being more remote from the stimulus word than the preceding one. If a subject employs such a strategy and as a result is able to overcome the stalemates he experiences, then this strategy would acquire some efficacy for the subject. It would be an effective method of thinking up original responses to give to the stimulus words.

When subjects who have had this experience are confronted with the Unusual Uses Test whose title even implies that it is a test of originality, they adopt the same objective which in turn recruits the strategy that now has demonstrated efficacy for attaining this objective. That is, subjects who try to be original in the Unusual Uses Test and who undertake to accomplish this aim by following out a line of thought to more remote ideas would likely produce more unusual uses.

This training procedure and the original experiment by Maltzman, _et. al._, are interesting for several reasons. First, Maltzman and his associates argue that their measure of originality is an adequate criterion for research in this area. They began their research using Maier's two-string problem, but abandoned it because of questionable reliability. They substituted the Unusual Uses Test as a criterion for measuring transfer effects in their research. The questionable thing about their approach is that the only standard of acceptability for the products of thought is the gross output of ideas. The feasibility of the final uses proposed is very questionable and the simple listing of many uses, no matter how absurd, seems not necessarily to be a facilitation of problem solving or of creative thinking.

The primary advantage of using insight problems like those employed in this research is that a more realistic criterion of acceptability or of creative or productive thinking is built into them. It is assumed that a battery of such problems will overcome the major objection of Maltzman, _et. al._ Hence, one of the objectives of this project is to further develop a battery of insight problems for use in this and other problem solving research in this area.

A second interesting thing about the original experiment is the interpretation proposed by Maltzman, _et. al._, to account for their findings. They propose a behavioristic explanation. They maintain that the nonspecific transfer effects observed on the Unusual Uses Test were produced by "a complex kind of mediated generalization."

More specifically, they maintain that the intraverbal associations in an adult are enormously extensive and complex. Every verbal response is probably associated to some degree with every other one. The intraverbal associations between the common verbal responses are stronger than those between the common and the uncommon responses. Likewise, the association among uncommon responses are relatively stronger than between common and uncommon responses. "The evocation and reinforcement of uncommon responses will, through complex kinds of mediated generalization, therefore increase differentially the probability of occurrence of other uncommon responses even though they do not ordinarily occur to the same stimuli as the original reinforced responses." (Maltzman, _et. al._, 1961, p. 240). This interprestation is based on the assumption that man is a passive, reactive organism, an assumption that hardly seems to be consistent with the facts. People seem always to be trying to figure out what they are supposed to be doing and what the experimenter is trying to accomplish. It seems reasonable that these strivings would have something to do with what they get out of an instructional experience. Hence, another objective of this research is the replication of the basic training experiment with an attempt being made to get additional information from the subjects in order to evaluate more effectively alternative explanations for the nonspecific transfer effects.

One final implication of the original experiment is that the basic training procedure embodies the principle of induced stalemate with opportunity for the subject to experiment with alternative strategies for attaining the objective of the task. It seems reasonable that the basic procedure can be modified in ways that will induce subjects to experiment with special strategies or heuristics the experimenter may want to teach. In this project, the basic procedure was modified into a technique for teaching a heuristic that could conceivably mediate nonspecific transfer effects to the battery of insight problems.

A clinical and theoretical analysis of the solving process lead to the discovery of a strategy called the method of "property analysis." This strategy appears to be a heuristic. The following reasoning supports this conclusion. The strategy in question involves thinking of the properties of the elements in the problem situation. Properties are the kind of knowledge that can provide the basis in the knowledge systems of people for relationships between elements they know about. Relationships are intimately involved with other knowledge systems referred to as solution principles. Once discovered and thought about, a relationship, by virtue of this involvement, suggests a generic principle which becomes the basis for the specific solution to the problem. In other words, because of the way our knowledge systems are organized, thinking of solution-relevant properties of elements in a problem situation leads to the invention of a solution. It is a method of capitalizing on the nature of our knowledge systems. If this "propertizing" strategy does, in fact, suggest solutions, then it would qualify as a heuristic. It would serve the fairly general objective of a new approach that might lead the subject to invent a new solution to the problem to be solved. It would appear to be an excellent strategy to employ when faced with failure or with a temporary stalemate.

The multiple association procedure was modified and employed as a technique for teaching this heuristic. Subjects are read a list of 25 words, all of which designate physical objects. The subjects are required to respond by giving properties of the designated objects. One experimental group in this project received this treatment on the assumption that the task would force them to develop and experiment with strategies for thinking of the properties of things. Should they employ the same strategy on the insight problems, it is assumed that they would be more likely to think of solution-relevant properties and be led to think of the solutions. If they did this, their problem solving would be facilitated as a result of the training.

A second group was given the same instructions plus special instruction in the use of a method for thinking of properties when this becomes more difficult in the later stages of the training task. Of course, the hypothesis is that this training will facilitate the problem solving of experimental subjects on the battery of insight problems. Hence, the third primary objective of this project is to attempt to teach subjects a particular strategy that will mediate nonspecific transfer effects to the insight problems.

Implicit in the idea that the problem solving of subjects can be facilitated by teaching this strategy is the assumption that thinking of solution-relevant properties does in fact lead subjects to discover solutions to problems. Since this assumption is so basic to the whole experiment, it is tested separately in the following way. Subjects in an experimental condition are provided with hints in the form of solution-relevant properties of certain elements in the situation. The hypothesis is that these hints will lead to more solutions by these subjects. If this hypothesis is supported by the results of the experiment, then it is at least theoretically possible to teach subjects to give themselves hints by thinking of the properties of elements in the problem situation.

Three experiments were conducted in this project. The aims of the first experiment were (a) to further develop a battery of insight problems for use in this and similar problem solving research, (b) to ascertain what properties of the elements in each insight problem are relevant to the solution, and (c) to give these properties as hints to experimental subjects in order to see if thinking of properties is a potential heuristic. The aims of the second experiment were (d) to develop a questionnaire to be given subjects following the training experience in order to obtain more information on how the training affects the subjects, and (e) to replicate the basic experiment of Maltzman, et. al., with the administration of the post-experiment questionnaire added to the experimental procedures. Finally, the aims of the third experiment were (f) to provide subjects with experience on the original and modified forms of the training procedure, and finally (g) to assess the effects of the original and modified treatment conditions on the battery of insight problems and the Unusual Uses Test.

Experiment I

In this experiment, the battery of insight problems was further developed by adding additional problems to a shorter battery employed in previous research. Each of these problems was pre-tested on a number of individuals in order to assess their suitability for inclusion in the final assessment battery and in order to ascertain what properties of the elements seemed to be most relevant to the acceptable solution or solutions. Nine problems were finally selected and analyzed in this manner. (See Appendix A)

In the second phase of the experiment, three groups of twenty subjects each were constituted by random assignment of volunteers from introductory psychology courses. A control group received the battery of insight problems with no special treatment. One experimental group received a single hint in the form of a solution-relevant property for each of the insight problems in the battery. A second experimental group received more than one hint for each problem where more than one solution was regarded by the judges as feasible. (See Table 1 for a summary of the experiment design).

Two criterion scores for this experiment were (a) the number of acceptable solutions proposed by each subject and (b) time in seconds to first feasible solutions. These scores were analyzed statistically. Both of the experimental groups produced significantly more feasible solutions to the insight problems and arrived at their first acceptable solutions sooner than control subjects. The experimental groups did not differ significantly from each other by other criterion.

The results of this experiment confirm the hypothesis that if subjects think of the solution-relevant properties they will be lead more quickly to the solutions to these problems. This means that the strategy of thinking of the properties of elements in a problem situation is a potential heuristic in that if one should hit upon a solution-relevant property by this method, he would probably be lead on to the solution. Whether or not subjects can be taught to give themselves hints, so to speak, is a problem that'is tested in the third experiment in the project.

Experiment II

The aims of this experiment were (a) to provide subjects with experience on the original and modified forms of the training procedure, and (b) to assess the effects of the original and modified treatment conditions on the battery of insight problems and the Unusual Uses Test.

The first phase of this experiment consisted of a clinical-theoretical analysis of the performance and learning processes involved in the training procedure employed by Maltzman and his associates in their research on training. The results of this pre-experiment analysis revealed that on subsequent repetitions of the training task, some subjects tried to think of original responses, others tended to associate to their own prior responses rather than to the stimulus word, either subjects responded with synonyms or antonyms, other subjects employed yet different strategies. There was considerable evidence in this clinical type analysis that all subjects are busily considering the experimenter's purposes, what they ought to be doing, and the like, while they are taking the training procedure.

Of course, these observations were purely anecdotal and could hardly be the basis for sound conclusions. They did provide the basis for the development of a questionnaire to be administered to subjects following the replication of the original experiment by Maltzman, et. al. This post-experiment questionnaire required the subjects both to report their suspicions, what they tried to do, and to give their opinions on the possible effects of the training experience on them.

The second phase of the experiment was the actual replication of the original experiment by Maltzman, et. al., in which a kind of nonspecific transfer of training was observed. Four groups of 35 subjects each were constituted by random assignment of volunteers from introductory psychology courses. One group of subjects received a training list of 25 words with instructions to respond with the first word that comes to mind. They were given the list five more times with instructions to respond again but with different words than they gave the first time through the list. This is the same-stimulus-different-response condition. A second group of subjects received the same treatment except that they were instructed to respond with the same word on subsequent repetitions of the list. This is the monotony condition. A third group received essentially the same instructions but had six different lists with no list being repeated. This is the six-list condition. Finally, a fourth group received the 25 word training only once.

After training, each group received a new list of 25 words with instructions to respond with the first word that comes to mind, and then the Unusual Uses Test. Following these, all subjects in all experimental groups were given the post-experiment questionnaire in order to obtain additional information on what they learned that could mediate the nonspecific transfer effects that were expected.

The criterion scores that were used in the analysis of the results were (a) an originality score based on the commonness of responses to words in the test list, (b) a mean originality score, a simple originality based on the commonness of subjects' responses to the Unusual Uses Test, (c) a fluency score based on the total number of responses of subjects to the Unusual Uses Test, and (d) responses of subjects to the post-experiment questionnaire.

The results on the post-experiment questionnaire indicated that the majority of subjects in all groups suspected that the real purpose of the experiment was not to study reaction time. When the suspected purposes of the experiment were classified, a variety of purposes were listed. While some subjects in each group suspected it might be some kind of experiment in original thinking, there was no difference in how often this was suspected in the various groups. Therefore, the hypothesis that subjects in the experimental groups become more original because they get the idea from the training procedure that it is a measure of originality is not supported by the data.

When the methods subjects report employing on the second 25-word list--the test list--are classified and examined, there is evidence that subjects in the experimental groups may have employed relatively more different stratagies in order to think of associations during the later repetitions of the training list while control subjects appear to have responded by giving synonyms and/or antonyms. An examination of strategies employed by some of the subjects in the respective groups suggested that experimental subjects were trying to think of associations, no matter how remotely related they might be to the stimulus words while control subjects appear to have been concerned with thinking of associations such as synonyms that were closely related to the stimulus words.

This difference suggests the hypothesis that all subjects who receive the instructions and the training list for the first time assume that the response words should be relatively closely related to the stimulus words but that the nature of the same-stimulus-different-response condition is such that subjects receiving it are forced to revise this assumption and adopt a new one that calls for responses that may be unrelated or remotely related to the stimulus words in the training list. This revised assumption would give rise to a new objective, to think of response words, no matter how closely related to the stimulus words they might be. This new objective would recruit new or different strategies for thinking of new associations. Should these strategies serve the subjects'purposes, they would likely be employed again when the person is faced with a similar objective.

If this is what the training experience does to the subjects, then how could this account for the transfer effects to the test list of 25 new words? The answer would be that on the new task, subjects carry over the same liberal interpretation of what is expected of what they are to do, and this leads them to adopt the more liberal objective which in turn recruits the same strategies employed on the training list to think of new words. These strategies lead to more unique, uncommon or original responses to the words in the test list.

The transfer effects to the Unusual Uses Test would have to be accounted for in essentially the same way. The control subject would assume that he should list uses that were realistic and practical. The experimental subject who had rejected this assumption in the training task would assume on the Unusual Uses Test that he could give any kind of use he could think of, no matter how unrealistic or even ridiculous it might appear.

The responses of experimental subjects to the question about their strategy on the Unusual Uses Test indicate that they tried a variety of methods, most of which appear to have been based on the assumption that any old use will be acceptable while responses of control subjects to the same question suggest that they were restricted to more realistic and reasonable uses. In other words, the results on the Unusual Uses Test are consistent with the interpretation suggested by the data on the effects of the training on the test list. Subjects appear to have revised their assumption about the kind of responses that will be acceptable during the training experience. They then adopt an objective consistent with this. This objective in turn recruits strategies for serving that purpose. On the transfer tasks, the assumption carries over with the more liberal objective. The same and/or similar strategies are employed again and these recruit more unique, uncommon, and original responses.

Experiment III

The aims of this experiment were (1) to provide subjects with experience on the original and modified forms of the training procedure originated by Maltzman, *et. al.*, and (2) to assess the effects of the original and modified treatment conditions on the battery of insight problems and the Unusual Uses Test.

In this experiment, various training procedures were administered to experimental and control subjects. These were followed by the battery of assessment problems, the Unusual Uses Test, and then a post-experiment questionnaire.

There were six treatment groups in all. The first group , the control condition, received no special training. The second group received the same treatment as the six-list group in Experiment II. The third group received the same treatment as the same-stimulus-different-response group in Experiment II. The fourth group received essentially the same treatment as the same-stimulus-different-response subjects except that they were required to respond with the properties of objects the words designated. This was the "properties" condition. The fifth group received the same treatment as the properties group plus instructions in a special method of thinking of new properties when the more obvious ones had been given. This was the "method" condition. Finally, a sixth group received the same treatment as the monotony subjects in Experiment II. Following the training all groups received the battery of insight problems, the Unusual Uses Test, and a post-experiment questionnaire.

The criterion scores employed for the Unusual Uses Test in order to test the effects of the training on the subjects were the same as those employed in Experiment II. The results of the analysis of variance revealed that the groups did not differ significantly on any of the scores for this task. This was perplexing since the same training conditions produced significant increases in originality on this task in Experiment II.

Since the same criterion task had been given to subjects in the two experiments, it was possible to compare the means of the subjects who received the same treatment in the different experiments. This was done in order to ascertain whether the experimental subjects in Experiment III were more or less original than their counterparts in Experiment II, or whether the control subjects in the respective groups differed from one experiment to the other. The results revealed that subjects in the monotony condition in Experiment III tended to be more original on the Unusual Uses Test than subjects receiving the same treatment in Experiment II. This suggested that having the latter subjects take the battery of insight problems after the training but before the Unusual Uses Test might have disrupted the assumptions they would ordinarily have carried over to the Unusual Uses Test. The results also revealed that subjects in the same-stimulus-different-response condition of Experiment III showed less originality on the Unusual Uses Test than did their counterparts in Experiment II. This suggested that the interpolated insight problems may have had a dampening effect on their Unusual Uses Test performance. This is less reasonable and, therefore, more difficult to account for than the difference between the monotony subjects in the two experiments.

Perhaps the most important implication of this finding is that whatever mediates the transfer effects is relatively unstable and subject to modification by certain kinds of interpolated experience.

The criterion score employed in order to assess the effects of the training on the battery of insight problems was the number of acceptable solutions proposed. When the distributions for the various groups were submitted to an analysis, the results revealed that there was no significant difference among the respective group means. The training procedures failed to produce the expected result on this task.

In order to ascertain what information might be available that would shed light on what might have happened, a careful analysis was made of the raw data. This analysis revealed that while the various groups did not differ on the number of acceptable solutions proposed, they did differ significantly on the total number of solutions, proposed acceptable and unacceptable combined. In other words, one can calculate a fluency score on the battery of insight problems just as he can for the Unusual Uses Test. Many of the solutions proposed by experimental subjects to the insight problems were ridiculous and unrealistic. However, this is also true of the uses they proposed for items in the Unusual Uses Test.

An examination of the various means of the experimental and control groups reveals that the same-stimulus-different-response training procedure produced the greatest number of solutions, acceptable and unacceptable. The condition in which subjects responded to the same stimulus words again and again but with the properties of the objects designated by those words also produced significant increases in fluency by this standard. This procedure was not significantly less effective than the regular same-stimulus-different-response procedure, but the mean was slightly less.

This finding turns out to be highly consistent with the conclusion suggested by the results of Experiment II. Recall that in that experiment the evidence seemed to point to the conclusion that the basic training procedure employed in the original experiment by Maltzman, et. al., forced the subjects to revise their assumption about how closely related the response words should be to the stimulus words in the training list. While they initially assumed that the words should be closely related, later on in the training they assumed that the words need not be closely related. In other words, the training leads them to adopt a more liberal interpretation of the instructions. This gives rise to a new objective that is consistent with this interpretation. The objective recruits new strategies which lead to the successful performance of the task. This same assumption is transferred or carried over to the Unusual Uses Test. The liberal interpretation of the instruction gives rise to an objective to give uses of any kind, no matter how ridiculous or unrealistic. The same strategies may be recruited that were successful on the training task. The result is more unusual uses for the experimental subjects.

If this is, in fact, what the subjects learn from the training procedures that affected their Unusual Uses Test performance, then it should also mediate any effects the training might have on the battery of insight problems. The results of this experiment seem to support the conclusion that the experimental subjects carried over their liberal interpretation of the instructions from the training tasks to the insight battery. Their significantly greater fluency is evidence of this. The fact that they failed to propose significantly more acceptable solutions seems to suggest that their standards for evaluating the acceptability of a solution were low, missing or suspended. In effect, the training may be helping the subjects apply the brainstorming principle of suspended judgment.

One important implication of this finding is that the criterion task which is primarily a measure of fluency or unusualness is not an adequate criterion for judging overall problem solving facility. In the final analysis, some criterion of workability or feasibility of a solution is necessary. The insight problems have built into them such a criterion. For this reason, the battery of insight problems would appear to be a more useful instrument for research in this area than the Unusual Uses Test. A training procedure that can effect a facilitation of problem solving on this battery will indeed be interesting provided the transfer is nonspecific.

Another implication of these findings is that more attention should be paid to the assumptions people make when they undertake some educational activity or some task that is presumed to reflect something about their ability. Psychologists have talked for years about the importance of unwarranted assumptions people make while solving problems. However, a systematic and sustained attack on the matter from this point of view has not been possible primarily because there has been no adequate theory of knowledge and instruction in which the idea of an assumption makes sense. In order to make such a notion meaningful and useful, it must be embedded in the context of a larger system which makes it possible to relate the assuming process to processes such as the person's objectives and to structures such as his knowledge systems. The theory described in this report makes the assuming process explicable and accounts for it as part of other ongoing cognitive processes.

The hypothesis with which this project was undertaken placed an emphasis upon the strategies people employ. The expectation was that one could induce nonspecific transfer by teaching strategies. Apparently one cannot teach strategies without also providing subjects with a new objective which is served by those strategies. Furthermore, the objectives a person adopts seem to be based on the conception he develops of the problem situation and what he thinks is called for by the task given him. It is in the process of developing this conception that the subject makes various conclusions, some of which are unwitting and others of which may be recognized. These conclusions are the assumptions on which the subject proceeds.

The results of the experiment are consistent with either the interpretation proposed by Maltzman, et. al., or the interpretation developed in this report. While none of the evidence obtained in any of these experiments makes possible a definitive test of the alternative positions, it seems to indicate to this investigator that the assumption of a passive organism is untenable and that a theory of knowledge and instruction that takes account of the assumptions they make and, hence, of what they are trying to accomplish, would be more useful for dealing with nature of knowledge and the processes involved in its acquisition, retention, and utilization.

References

Maier, N.R.F. Reasoning in humans: II. The solution of a problem and its appearance in consciousness. J. comp. Psychol., 1931, 12, 181-194.

Maier, N.R.F. An aspect of human reasoning. Brit. J. Psychol., 1933, 24, 144-155.

Maltzman, I., Simon, S., Raskin, D., & Licht, L. Experimental studies in the training of originality. Psychol. Monogr., 1960, 74 (6, Whole No. 493).

Wertheimer, M. Productive thinking. New York: Harper & Brothers Publishers, 1945.

Dunker, K. On problem-solving. Psychol. Monogr., 1945, 58 (Whole No. 270).

Bruner, J. S., Goodnow, J. J., & Austin, G. A. A study of thinking. New York: John Wiley & Sons, Inc., 1957.

Miller, G.A., Galanter, E., & Pribram, D.H. Plans and the structure of behavior. New York: Henry Holt & Co., 1960.

Newell, A., Shaw, J.C., & Simon, H.A. Elements of a theory of human problem solving. Psychol. Rev., 1958, 65, 151-166.

Polya, G. How to solve it. Princeton: Princeton University Press, 1945.

Craik, K. The nature of explanation. Cambridge: Cambridge University Press, 1943.

Piaget, J. The construction of reality in the child. New York: Basic Books, Inc., 1954.

Daniels, P.B. The teaching and learning of heuristic analysis. Unpublished doctoral dissertation, Harvard University, 1961.

Osborn, A.F. Applied imagination. New York: Scribner's, 1953.

Christense, P.R., Guilford, J.P., & Wilson, R.C. Relations of creative responses to working time and instructions. J. exp. Psychol., 1957, 53, 82-88.

Meadow, A. & Parnes, S.J. Evaluation of training in creative problem solving. J. appl. Psychol., 1959, 43. 189-194.

Meadow, A., Parnes, S.J., & Reese, H. Influence of brainstorming instructions and problem sequence on a creative problem solving task. J. appl. Psychol., 1959, 43, 413-416.

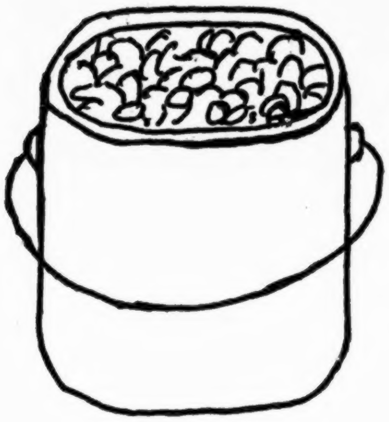
Ruger, H.A. The psychology of efficiency: an experimental study of the process involved in the solution of mechanical puzzles and in the acquisition of skill in their manipulation. Arch. Psychol. N.Y., 1910, 2 (No. 15).

Lindquist, E.F. Design and analysis of experiments in psychology and education. Boston: Houghton Mifflin Co., 1953.

Appendix A

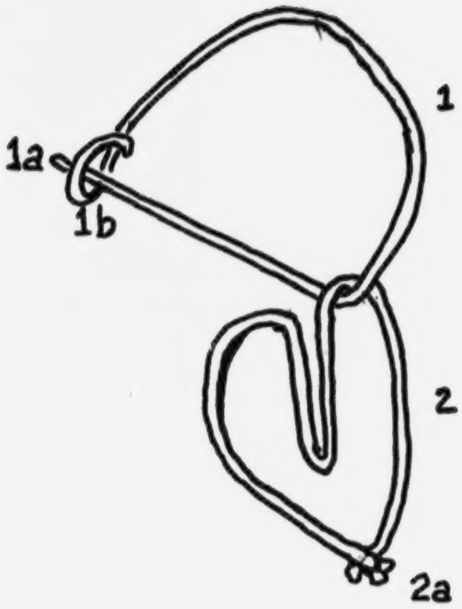
The Battery of Insight Problems

The coins problem



How might you go about finding the exact number of pennies a can like this might contain without counting each penny individually? You may use in your solution any materials you wish except a coin counter. Try to think of at least three solutions.

The heart-bow problem

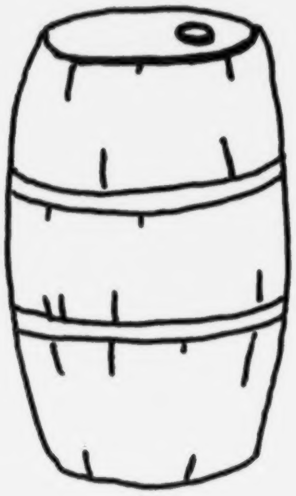


1. a bow-shaped piece of wire with one end (1a) projecting through a loop on the other end (1b)
2. a heart-shaped piece of wire interlocked with the first piece

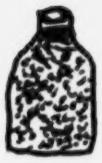
How would you go about getting these two pieces of wire apart--separated from each other--without removing the end (1a) from the loop (1b), without undoing the loop (1b), without undoing the heart (2a), and without breaking or cutting either of the pieces of wire?

Write your answer here:

The oil-in-bottle problem



1

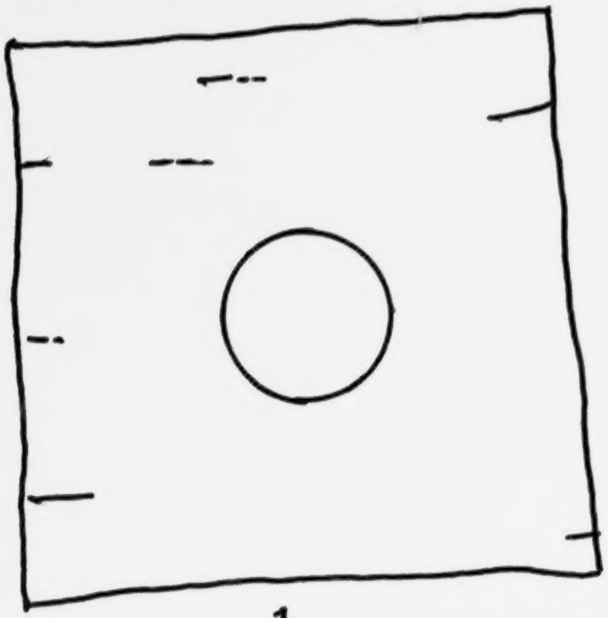


2

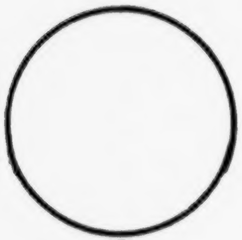
1. a barrel full to the top of oil
2. a glass jar full of water

Using only the materials pictured above, how would you go about getting the bottle full of oil without moving the barrel, without removing its top or changing it in any way?

The dime-quarter problem



1



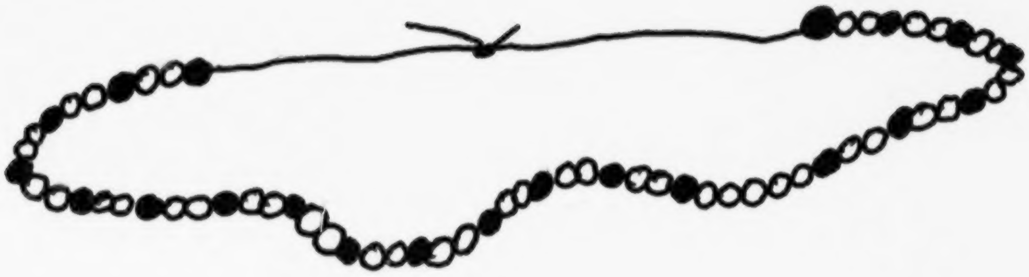
2

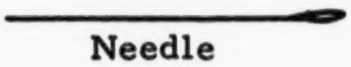
1. a square piece of paper with a hole in it exactly the size of a dime

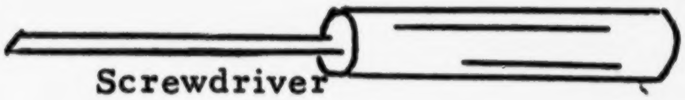
2. a quarter

How would you go about getting the quarter to pass completely through the hole (dime size) in the paper without tearing the paper or altering the quarter in any way?

The beads problem

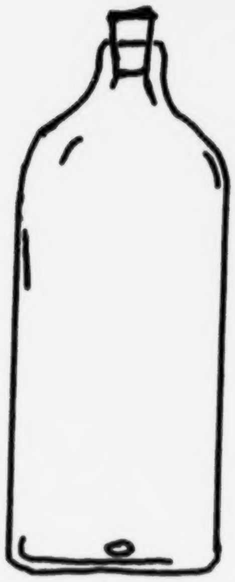






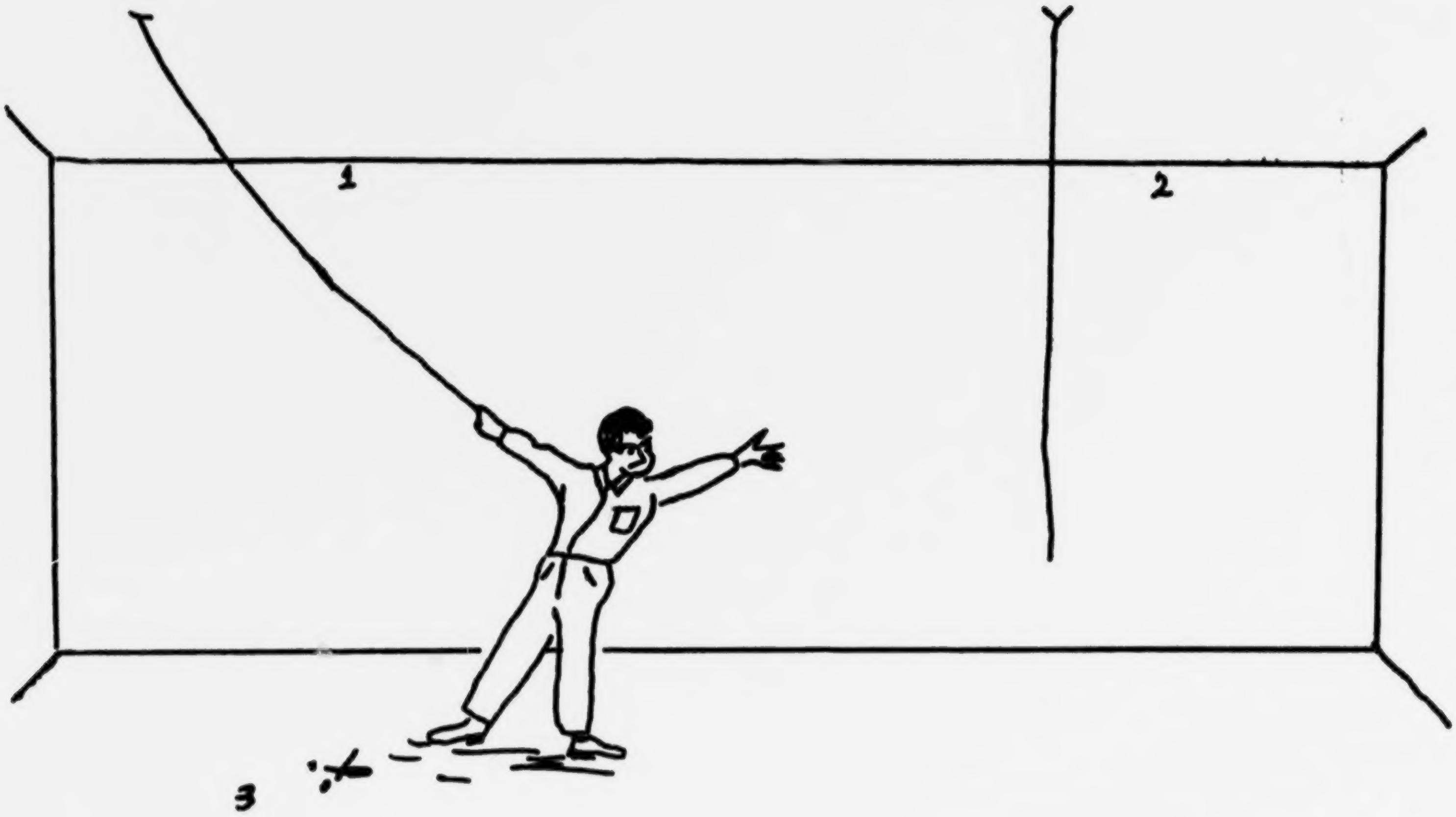
How might you go about making a single regularly repeated pattern of beads without either unstringing or restringing the beads, and without either knotting or breaking the thread? You may or may not want to use the materials pictured above but no additional materials are necessary.

The dime-in-the-bottle problem



How would you go about removing the dime from the bottle without removing the cork from the bottle, without damaging the cork or the bottle or the dime, and using no other materials?

Maier's two-string problem

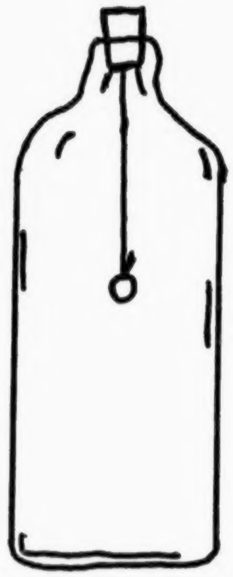


1. a light string
2. a light string
3. a pair of scissors

If you were this person, using any of the materials pictured above, how would you go about getting hold of both strings at once so that you could tie their ends together? (cutting the strings is prohibited in the solution)

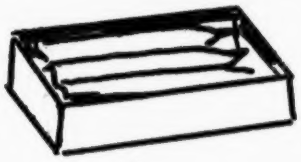
Write your answer here in enough detail to make it clear to anyone how you propose to do it:

The suspended-ring problem

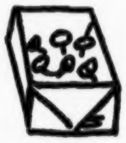


Pictured above is a bottle with a cork in the top and a ring suspended in the center of the bottle by a string that is attached to the cork. Without touching either the bottle or the cork and without damaging or changing them in any way, how might you go about making the ring drop to the bottom of the bottle?

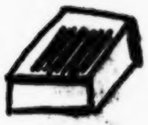
The mount-the-candle problem



1



2



3

1. a box containing 3 candles (each candle is 6 inches long and 1 inch in diameter)
2. a box of ordinary thumb tacks
3. a box of matches

Using any of the materials pictured above, how would you go about mounting the three candles vertically (in their upright position on the side of a wall made of soft wood? (The idea of sticking the candles to the wall with melted wax will not work)

Appendix B

The first two lists are the stimulus words employed in Experiment II, the replication of the experiment originally conducted by Maltzman, et. al. (1960). All other lists were employed in Experiment III.

Training List

1. pencil
2. shut
3. dark
4. scissors
5. white
6. black
7. sour
8. blue
9. boy
10. butter
11. table
12. bitter
13. stork
14. swift
15. tobacco
16. blossom
17. yellow
18. bake
19. hammer
20. rough
21. loud
22. frosty
23. brown
24. sweet
25. mutton

Test List

1. rich
2. needle
3. ocean
4. slow
5. carpet
6. ink
7. thirsty
8. man
9. window
10. knife
11. village
12. city
13. stove
14. high
15. voyage
16. girl
17. cow
18. fast
19. red
20. short
21. woman
22. lamp
23. hot
24. frog
25. whisky

Training Lists

1st List

1. sponge
2. glove
3. chalk
4. candle
5. leather
6. box
7. marble
8. razor
9. rifle
10. twine
11. broom
12. rug
13. stove
14. shoe
15. snow
16. valley
17. blood
18. sun
19. letter
20. milk
21. post
22. cup
23. cloud
24. stone
25. nest

2nd List

26. camera
27. bridge
28. radio
29. wagon
30. cave
31. ax
32. harp
33. agenda
34. brush
35. tail
36. anchor
37. sword
38. theater
39. pump
40. antler
41. anvil
42. balloon
43. banjo
44. flag
45. canoe
46. muscle
47. gasoline
48. beacon
49. lamp
50. saddle

3rd List

51. pulley
52. bone
53. stairs
54. bugle
55. cannon
56. carp
57. catapult
58. chariot
59. clamp
60. cradle
61. dish
62. diamond
63. magnet
64. elevator
65. fang
66. hoof
67. fingerprint
68. forcept
69. fort
70. map
71. chisel
72. handcuff
73. harness
74. turtle
75. hinge

4th List

76. hourglass
77. hurdle
78. spoon
79. mushroom
80. partition
81. shell
82. pyramid
83. scythe
84. silk
85. sleigh
86. stencil
87. harpoon
88. tile
89. tooth
90. tweezer
91. constellation
92. wigwam
93. wrench
94. arm
95. bag
96. bear
97. bank
98. bird
99. book
100. boat

5th List

101. dog
102. door
103. dress
104. egg
105. eye
106. foot
107. fire
108. gate
109. glass
110. grass
111. hair
112. iceberg
113. rainbow
114. stone
115. suit
116. train
117. wife
118. wing
119. wind
120. baby
121. car
122. chair
123. club
124. coat
125. cotton

6th List

126. cow
127. crowd
128. dance
129. dinner
130. ear
131. enemy
132. farmer
133. floor
134. hall
135. iron
136. moon
137. newspape
138. officer
139. ocean
140. path
141. path
142. report
143. ring
144. table
145. table
146. carpet
147. ink
148. pencil
149. button
150. tobacco

Appendix C

The Unusual Uses Test

Uses Test

In this test you are to list as many uses as you can think of for a common object. In this booklet, there are six pages. On each page is the name of an object and the most common use for it. Also on the page are numbered lines for writing down the other uses you think of.

Write as rapidly as you can. Give all the uses you can think of. Your answers do not have to be complete sentences. You may use short phrases.

Do not turn the page until the signal is given. When told to do so, turn the page and begin listing uses for the object named at the top of the page. You will be given three minutes in which to write uses for that particular object.

When told to do so, but not before, turn to the next page and begin writing uses for the object named there. Are there any questions?

DO NOT TURN PAGE UNTIL TOLD TO DO SO

Object: AUTOMOBILE TIRE

Conventional Use: use on the wheel of auto

Other Uses:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.
21.
22.
23.
24.
25.

**DO NOT TURN PAGE UNTIL SIGNAL IS GIVE

Object: A KEY

Common Use: to open lock

Other Uses:

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________
19. ____________________
20. ____________________
21. ____________________
22. ____________________
23. ____________________
24. ____________________
25. ____________________